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THE TWO SCHOOLS OF PLANT PHYSIOLOGY AS AT PRESENT EXISTING IN GERMANY AND ENGLAND.

BY E. L. GREGORY.

(Continued from p. 217.)

The nature of the experiments will be best understood by a brief statement of the outlines of his theory in regard to the processes by which the water is carried up. He regards the ducts, and to a certain extent, the tracheids, as reservoirs into which the water is passed from the absorbing cells. These ducts, except it may be in a certain period of the year when the so-called root pressure is taking place, are never filled with water but with alternating columns of air and water. All who are at all familiar with this subject will remember that this was the first argument against the new theory. How could the water pass up in the cell lumena when these were not themselves filled? It is claimed now that this very fact is the one which admits of such a possibility. That is, these alternating columns make a combination known as the Jaminschen chain, from the name of the Frenchman, Jamin, who was the first to compute the force exerted by a chain of air and water columns in a capillary tube. Such an apparatus was called by his name, and the discovery of such a system of chains in the ducts and tracheids of woody tissue has been the strong point in the new water theories. The manner of action of this chain may be seen at once, the meniscuses acting as

forces to prevent the motion of the water which would otherwise sink. In other words, the sole function of the chain is to prevent the water from yielding to the action of the gravity. In this way according to the distribution and tension of the air bubbles, the water is more or less evenly distributed throughout the whole stem of the tree and is ready for use whenever needed at different altitudes. The next step in the problem is to discover the factor by which the water is drawn out and set in motion upward. It is here that Professor Schwendener differs from nearly all the younger men who adhere even too zealously to his cause. In short, the last set of experiments which he made were for the purpose of disproving the claims of those who consider themselves able to follow all the successive forces which act in sending the water upward from the root hairs to the transpiring leaves. The question of lumen versus wall was not at all touched by these experiments. On the other hand, they were made to test the length of alternating air and water columns, diameter of tube, etc., and from these results a series of mathematical computations was made, it is true from data more or less uncertain, but yet with such allowances for extreme cases as to prove conclusively that some other force was necessary than those held sufficient by his contemporaries.

Pieces of wood were taken from the inner portions of the trunks of various trees, with apparatus allowing perfectly air tight processes. The pieces were transposed from the tube of the borer into glycerine or water from which all air had been expelled. From these computations it was shown that in no case would it be possible for the action of suction caused by the evaporation from the leaves to reach down much below the crown of the tree, and in case of trees with trunks from 50 to 100 metres long this might be considered proof against the possibility of the force reaching downward until it reaches that effected below by the forces acting in the lower part of the tree. The whole labor is merely to disprove certain theories, not to establish new ones.

In conclusion Professor Schwendener says the results agree with those expressed in 1867. Stated briefly it may be said

they prove that some other forces must be present besides those recognized by authors who claim to give an explanation of the mechanical forces acting in forcing the water upward. These forces must lie more or less scattered through the length of the trunk because they are concentrated at points at considerable distances from each other, and tensions arise which are not present. The Jaminish chain serves to hold the water in the ducts and tracheids from falling by its own weight; the living cells of the medullary rays and of the wood parenchym, in some manner as yet unknown to us, take the water held in these reservoirs and distribute it to places where it is needed.

Now contrast this with the explanation of Sachs, which is virtually the same as that held by all claiming that the wall is the chief path taken by the water in its ascent. This may be stated as follows: Water is able to reach the tops of the trees fast enough to supply the lack caused by transpiration, owing to the peculiar quality residing in the micellæ of the lignified cellulose, which enables the water molecules to move with great rapidity, when the equilbrium is once disturbed by transpiration above. This peculiar quality is entirely lost when once the water has dried out of the walls so the micellæ touch each other. Imbibition may occur as in ordinary cases but the micellæ have lost that character which enabled the water particles to move with such rapidity. One of the favorite experiments given in favor of this theory is that of Th. Hartig with the stick, which being held upright and a drop of water placed on its upper surface, it at once disappears and a drop of water appears below. Now it is admitted that this succeeds only when the wood of the stick is saturated with water. Schwendener's explanation of this phenomenon is extremely simple and takes away all evidence of the rapidly moving particles or molecules of water in the wall. In this saturated condition, there would be continuous water columns inside the tracheids, the cut surface at the top transpires enough to form the concave meniscuses for all these columns, the added drop is sufficient to destroy these meniscuses, the water columns sink until the drop is drawn in and new menis-

cuses again form, preventing farther sinking. In case the wood is partly dried, instead of a drop appearing below, the water at the top sinks in without farther visible result either at once or slowly. In this case there are no continuous water streams as before, they are broken by internal meniscuses forming the chain.

Contrast now the methods of reasoning used in the two cases. It is admitted on both sides that all the mechanical forces here in play whose action we understand, are not sufficient to cause the water to ascend higher than about 30 feet. Sachs, therefore, affirms the presence of a quality in the micellæ of the wood, which if it existed there would account for the water rising. There is no other proof that this quality exists than simply this fact. This statement, perhaps, should be modified by adding, there is no proof which is considered conclusive.

On the other hand, the theory as taught by Schwendener stops short of the assumption of a mechanical cause. No known mechanical forces can be found active here which are sufficient to explain the result. As there is always one factor of whose manner of action we are ignorant, namely: the action of living matter, he assumes this to be the factor which accomplishes that part of the result not reached by mechanical causes. This inference is supported by the arrangement of the living cells in connection with the ducts and tracheids holding the water. For example the presence of wood parenchym around those ducts which are otherwise not in connection with the medullary rays.

In regard to the experiment of Hartig before referred to, it may be of interest to those not familiar with the anatomy of the tissues through which the water passes if a few words of added explanation are given. In the saturated piece of wood we have said there were continuous water columns in the tracheids, these are continuous only in the sense of there being no air columns present. These tracheids are closed cells, therefore there is the interruption of the cell walls at intervals in the otherwise continuous columns. So that according to Schwendener's view all that is proven by the drop of water

experiment is, the amount of resistance of filtration. This in a piece of wood ten metres long in an upright position is less than one atmosphere. Similar experiments have been tried, the stick being placed obliquely; from these it has been proven that a column of water 12 centimetres in height is able to move a water net 100 centimetres or one metre in length.

Now if we turn from the discussion of this old and long disputed question to one of the most recent and perhaps least known, namely: "Turgor as the necessary condition of growth" we shall find the same principle again, only illustrated in a different way.

A cell is said to be be turgescent when the hydrostatic pressure within exceeds that of the atmosphere without. The common teaching regarding the manner of growth of cell wall in surface is, that the cell must be in the turgescent state, that is that the actual growth depends upon and is the result of such condition of cell wall. Owing to the pressure within, the micellæ of the wall are supposed to be separated from each other until the extreme limit of elasticity is reached. In this way place is made for the new particles of matter between the old.

This theory is known in botanical literature as the Sachs-De Vries theory as it was first suggested by Sachs and afterward supported by De Vries. It is often referred to as the one sustained by Naegeli, but a careful study of his works shows that what he says upon this subject has reference to tissue tensions for the most part, rather than to simple turgor.

It is now claimed by Schwendener that there is no proof whatever that the surface growth of the wall depends upon turgor, and on the contrary, that there is considerable evidence against this assumption. For example, it has been shown that cells having an excess of turgor, are not growing at all, while cells are found in a state of great activity whose turgor is very small. One and one-half atmosphere is considered about the medium for ordinary turgescent cells.

Again, in a certain kind of tissue found in stems of water plants and others where large air spaces occur, growth of wall

takes place in direct opposition to a turgor force, that is, the wall grows inward into a cell which is strongly turgescent.

There is also one other ground for the position taken by Schwendener's school in reference to the relation of turgor to growth. This is certain facts connected with what is known as "Gliding growth," "Gleitendes Wachsthum." The principle included in this idea may be briefly explained as follows:

In the early stages of the secondary growth, during the time when the new cells are receiving or taking on their final character as vessels and libriform cells, etc., a growth takes place by means of the walls of one cell gliding along the wall of another. To explain this, it must be assumed that the walls of the young cell consist of two lamellæ; whether this is so from the beginning or not is entirely unknown, but at the stage of the development where the gliding growth begins, the two layers are there. These are not to be distinuguished by the highest power of the microscope, the wall appearing perfectly homogeneous under the most powerful lens. The subsequent growth is such as to prove that there are two lamellæ, as under no other assumption could such growth be possible.

This assumption has also other and positive facts sustaining it, besides the negative one mentioned above. In certain cases the thin young walls of cambium cells have been proven by maceration to consist of two or more lamellæ.

Now according to this principle there must reside in certain growing cells some force entirely independent of the mere mechanical one of pressure. In other words, there is an active as well as passive condition of growth and this active condition depends on certain properties of living matter and these properties are entirely outside and independent of what we know as mechanical force. Again we are brought to the same conclusion as before, there is a force residing in living matter of whose manner of action we are ignorant. That this force exists in this matter we have certain and positive proof.

This subject of turgor as before stated is one of the most recent questions and in a certain sense less important than the standard ones concerning the phenomena of growth.

To treat any one of the latter class fully would require more time than the limits of this paper allow. It is however, in these questions that the peculiar character of the new school is best expressed. The preference given to mechanical questions is evident from the list of subjects previously given as representing the line of physiological teaching Schwendener follows with his present classes. It is in connection with such questions that he has acquired his present reputation, and he is known best through the discussions of mechanical theories which are either peculiarly his own, or in which he opposes those of other leading physiologists.

But it by no means follows from this that he recognizes the mechanical forces as the only ones acting in the plant economy, nor that in his treatment of these, he fails to group their relations to the whole in a way to injure the unity of the entire subject. Rather than this it may be said he gives the first place to such questions because be believes this logical order of all investigation.

If the present aim of the scientist be to trace all the processes of living matter back to the action of chemical and physical forces, how can this result be reached unless we begin with the study of those laws whose action we know and understand?

It is in this sense that he says we are yet far from being able to take up the subtle and delicate questions connected with the action of living matter. There are many problems whose solutions lie nearer to us, and on these solutions depend our ability to handle the more remote and difficult questions of plant physiology.

One single illustration of what is here claimed may be found in what he says of the expression "Mechanics of Growth." Of this he says, "There is no such thing as the mechanics of growth, for it is the immediate result of the action of living matter and of this action we are ignorant."

In answer to a possible criticism as to there being but two main sources of the principles of plant physiology as they are now taught in Germany and England it may be said: there is

no question regarding the position occupied by Schwendener as leading the modern school in Germany.

In reference to the influence of Sachs on the leading text books of the present day, this is even more evident. While many other men of eminence in this field have contributed the results of their labors, not only by original research but also by writing text books, it is as yet true that they differ but little in methods of work or in the results obtained, from those general methods and principles which were first disseminated from the laboratory of Würzburg from the pen of the most popular and brilliant writer the world has yet produced in this special field of investigation.

In conclusion, therefore, it remains only to contrast once more, briefly the leading features of both schools.

In the one there is a tendency to put mere speculation and fanciful conjecture in the place of theory. Rather than to admit our present ignorance and weakness, effects are sometimes referred to causes which cannot be proven in harmony with those laws of nature which are recognized in other departments of natural science.

In the other the principal lines of research are in the direction of mechanical questions, but at the same time there is a clear and distinct recognition of our present limitations and of the relative value of such questions in the ultimate determination of the action of forces which are yet beyond our reach.

To the botanists of the present day and the future it remains to verify and reject, choosing the true and rejecting the false from both lines of research, till the decisions of the future shall make clear how much of error yet clings to the old school and the new.

PHENOMENA AND DEVELOPMENT OF FECUNDATION.

By H. J. Webber.

(*Continued from page* 111.)

ORIGIN OF FECUNDATION.

Having now discussed shortly the nature of the sexes and the effect of environment on them, we are ready to inquire into the origin of fecundation. There are several well-marked stages which we may select, that appear to indicate the probable course of the development.

1. Among certain of the *Mycetozoa* or *Myxomycetes*, the Slime Molds, we find some very suggestive forms that are apparently near the beginning of the differentiation. They are even more interesting, if possible, coming as they do from a class of organisms placed in either kingdom as the lowest group, their animal or vegetable nature being in question, although authorities seem to incline toward believing them of slightly preponderating animal nature. In the lower Slime Molds belonging to the group *Acrasieæ*, the life history is shortly this: From the spore (fig. 13, *a*), on germination there creeps out a naked motile mass of protoplasm, which takes nourishment, grows and reproduces rapidly by dividing, the products of the division being in each case similar swarm spores (fig. 13, *b–f*). After an extended vegetation of this sort, a number of the swarm spores collect into a "herd" and creep about in company for a time, after which two of them, apparently through accident, come closer together and adhere. Now the others close in and unite with these two, forming what is termed a *plasmodium* (fig. 13, *g*). But in this union each swarm spore retains its individuality, the union being merely an adhesion, not even a fusion of the individual protoplasms. They creep around in this plasmodium form for a time until ready to complete the cycle by forming the mature stage, which is accomplished by the plasmodium coming to rest,

collecting into a conical mass and each original swarm spore forming a single encysted spore (fig. 13, *h*).

Why this mechanical adhesion of the swarm spores into a plasmodium? It would seem a scheme adopted by the plant to better protect the encysted spores.

2. In the *Myxomycetes* proper (the higher Slime Molds), the mode of life is practically the same as in the *Acrasieæ*, but here, when the swarm spores fuse to form the plasmodium; the fusion is complete so far as the protoplasms are concerned, but still there is a lack of a thorough fusion of all the elements as the nuclei remain apparently ununited (fig. 14).

In some *Myxomycetes* we find an indefinite number of swarm spores uniting to form the plasmodium, but in others the number thus fusing is reduced to a very few. Thus coupled with the growing complexity of the fusion or *pseudo-conjugation* of the swarm spores we have a reduction, also, in the number of elements fusing.

3. Between this process and that described as conjugation there are many interesting intermediate forms. Sometimes three or four spores of low Algæ unite as if to gather sufficient strength to make a combined start in life. In *Dictyosiphon hippuroides* Areschoug[1] has observed and figured the union of three zoospores. In *Acetabularia mediterranea* DeBary and Strasburger[2] have figured the copulation of several swarm spores (figs. 15 and 16). This multiple conjugation has also been observed in *Hydrodictyon*, *Spirogyra* and some other algæ, and while considered as abnormal, is apparently by no means uncommon. Among animals the young form of the sun animalcule (*Actinosphærium*) though usually uniting in twos, have been observed by Gabriel to sometimes exhibit multiple conjugation. In this stage the number uniting is reduced to a very few, usually not more than three or four, and is probably accompanied by nucle fusion.

4. In *Ulothrix* we find the differentiation carried still further. Here the protoplasm of certain cells of the parent plant divides up into numerous little pyriform bodies (fig. 17), which

[1]Areschoug, Nova Acta., Reg. Soc. Ser. III, vol. x. Upsaliæ 1875.

[2]DeBary and Strasburger Bot. Zeit., Bd. xxxv (1877), p. 714.

on breaking out of the mother cell are seen to possess on their anterior end an eye spot and two cilia, by the rotation of which they dart actively here and there. These are the so-called *microzoospores.* Finally two of them from different parents, but in appearance precisely the same, come together and coalesce, their nuclei in this case, as in the last, probably fusing, but here only two uniting; while in the preceding stage there were more than two. This process we term conjugation, being the coalescence of two cells externally quite similar.

5. The next stage in the development is the union of more or less dimorphic elements. Both among plants and animals naturalists are agreed that it is impossible to draw any marked line of distinction between this and the preceding stage or conjugation. Sachs says "this differentiation presents a most complete series of gradations between the conjugation of similar cells and the fertilization of oospores by antherozooids, any boundary line betwen these processes being unnatural and artificial."

Cutleria, a seaweed of the branch *Oophyta*, is an interesting example of this stage. Here the female zoospores are large and borne singly in specialized cells in the parent. These on escaping, swim about for a time as do the microzoospores of *Ulothrix*, after which they come to rest. The smaller antherozooids now approach and conjugation takes place. In *Cutleria*, then, we have a union of differentiated cells for the first time, but they are yet both motile.

6. As an illustration of the next stage where we find complete differentiation as marked as in man, we select the Moss plant. In the mosses, the male and female organs are commonly borne on different plants. The egg cell is located at the bottom of a flask-shaped organ, the archegonium (fig. 18, *a*). The antherozooids (fig. 18, *b*) are small headed and biciliated, approaching in appearance very near to the spermatozoa of higher animals. In fertilization the antherozooids swim to and down the neck of the archegonium, at the bottom of which they find the quiescent oosphere or egg cell with which they fuse. The sexual cells of the moss plant, it is thus seen, unite two and two, as in the last case, but the differentia-

tion has been carried further, the female having become wholly incapable of independent motion, and the antherozooids have been gradually decreasing in comparative size. Here we have reached as high a development of fecundation as is probably found in the vegetable kingdom. (The stages in this development may be made clear by an examination of fig. 20, which is a modification of an illustrative diagram designed by Geddes and Thomson.)

I trust I have now made clear to you how fecundation probably originated, or rather the course it likely pursued in its gradual differentiation. Cell division, as we have seen, originated in almost a mechanical breaking apart of a mass of protoplasm. Conjugation and fecundation we now see, probably originated in the almost mechanical adhesion of the swarm spores of the *Acrasieæ*, followed by the mechanical fusion of the swarm spores of *Myxomycetes*, and gradually increasing in complexity until there is complete fusion (conjugation), then a fusion of elements differing in character. *Which is fecundation.*

DIFFERENTIATION OF SEX.

We may now direct our inquiry to the point in this evolution where sex becomes differentiated. In the conjugating swarm spores of the *Slime Molds* there seems to be no point where we can detect indications of a difference in the uniting individuals. So far as known there is no differentiation into male and female.

In *Ulothrix* (fig. 17) we begin to get a differentiation. In the conjugating microzoospores or planogametes (so called because of their similar character), it has been observed that planogametes produced in the same organ or gametangium will not coalesce with each other, but coalesce with planogametes from other gametangia. Here then, where the microscope fails to reveal any difference in the conjugating cells we nevertheless know from this fact that there must be some difference.

Ectocarpus siliculosus, one of the brown seaweeds, from the observations of Berthold, illustrates a rather different feature, by which we determine that the planogametes are really male

and female, although from external appearances we cannot recognize the difference between them. When the zoospores or planogametes are discharged from the mother cell, they do not differ by any morphological character. The females do not attract the males, but they swim around in the water and pass each other unnoticed. After a time, however, sex becomes manifest, and notably in accordance with the anabolic character of the female. Certain ones of the planogametes become motionless, draw in their cilia and assume a rounded shape (fig. 19, *a–c*). The female character of such cells is shown by the attraction they exert on the active males which collect about them in great numbers (a hundred or more), clustering at one side in a half circle. The anterior filament of each male is directed toward the female cell and is kept continually moving back and forth over it, the object being, it is thought, to provoke in the female planogamete genital excitation (fig. 19, *d*). After continuing to stroke the female for a time, one of the male planogametes leaves the circle and approaches the female, with which it gradually fuses, and fertilization is complete (fig. 19, *e–h*).

In the pond scums (*Spirogyra*, etc.), the reproduction of which is probably familiar to all, the filaments appear exactly alike, but the female character of one is shown by the cells of that filament containing all the spores resulting from the conjugation.

In *Cutleria*, mentioned above, the difference is manifested by the size of the conjugating cells, but as we noticed, both male and female are still motile.

In the common rock weed, (*Fucus*—fig. 21), the differentiation becomes marked by the external forms of the sexual cells. The female cells are large and motionless, while the male cells are becoming more intensely male by a comparative decrease in size and increase, if anything, in vigor. By the vigor of their motions they give the oosphere, around which they collect in great numbers, a rotary motion for a time until it is fertilized.

In the *mosses* (fig. 18) and *ferns*, discussed above, we reach a complete and highly developed state of sexuality, probably more complete than in the higher flowering plants.

We have now traced hastily the course of the differentiation into the sexes, but the question "what causes this differentiation?" remains.

Starting with an amœboid cell let us see what changes environment might bring about in this direction. We have already seen that nourishment evidently has considerable to do in the determination of sex. Now the physiological conditions in reference to nourishment to which a cell may be subjected are evidently three: preponderating anabolism, preponderating katabolism or a medium between these when katabolism and anabolism are equal. Suppose an amœboid cell is subject to a preponderance of anabolism over katabolism the result would naturally be, increase in size, accompanied by a growing regularity of outline, increase in reserve food material and decreased mobility. The result is surely plain, we would have differentiated an *ovum* or egg cell. On the other hand subject the amœboid cell to preponderant katabolism, and we would as reasonably expect a decrease in size and in reserve materials accompanied by increased activity and the development of organs to aid in more rapid motion through the surrounding medium. In short in this manner we reach intelligibly the differentiation of sperm and ovum, antherozoid and oosphere (fig. 60, and explanations).

THE TWO SEXUAL ACTS IN SEA WEEDS.

In certain of the Red Seaweeds we appear to have the curious and unparalleled occurence of two sexual acts in the life cycle of the plant, and the manner in which it is lead up to by transitional forms is very suggestive. The female reproductive organs which are borne on the same plant as the antheridia or on different ones consists usually of a group of cells, the *procarpium*, from one of which the egg cell proper, a long continuous closed tube, the trichogyne, grows out. In fertilization the spermatia are wafted about in the water until they come in contact with the trichogyne to which they adhere. The walls at the point of contact are absorbed, allowing the nucleus of the spermatia to pass over into the trichogyne and thus down to the egg cell, where it unites with the female pronu-

cleus (figs. 22 and 23). Shortly after fertilization a partition forms between the trichogyne and the egg cell, debarring the entrance of further spermatia and affording thus an excellent illustration of what Whitman has termed "Self-regulating receptivity." After fertilization the egg cell does not separate from its previous tissue connections, as in the oogonia of other green algæ, and the archegonia of the archegoniata, but remains in continuous connection with the hypogynal cells through which it is nourished.

In the simplest case (*Helminthocladieæ*) the ovacell develops from its surface many several-celled filaments, *ooblastemas*, as they are called, which form usually a closely compressed tuft. A single carpospore is developed at the apex of each of these ooblastema filaments (*Nemalion*, etc.) In this case, it will be noticed, all the ooblastema filaments are nourished through the egg cell.

In the *Gelideæ*, a slightly higher form, the fertilized ova from its surface cell develops a single filament, termed the ooblastema, which turns toward the axis of the branch and, ramifying abundantly, winds around this, sending branches into the highly nutritive outer layer of cells of the branch and connecting with some of these cells by the development of pits. Being thus abundantly nourished through this tissue, the branches of the ooblastema filament develop from each of the clavate erect terminal branch cells, either a single spore or short chains of two or more. In this case it is seen the ooblastema filament becomes in a sense parasitic upon the tissue of the parent plant.

In the families *Crytonemieæ* and *Squamarieæ* a single or at least few ooblastema filaments develop from the fertilized egg cell. These creep about until they come in contact with certain specialized cells of the branch known as auxiliary cells, with which they enter into connection directly or by the development of conjugation processes. In many cases the union thus formed is limited to a fusion of the protoplasm while the cell nuclei remain separate, (*Dudresnaya*). In this case a process issues laterally from that half of the conjugation

cell which represents the ooblastema cell which by its further growth gives rise to the spore complex (fig. 22).

In other cases (*Gloeosiphonia*) when the contents of the ooblastema filaments flow into the auxiliary cell, the *nuclei unite*, the fusion or conjugation being thus complete. In this case the auxiliary cell separates off as an individual cell and gives rise to a lateral cell which becomes the centre of a spore complex (fig. 23).

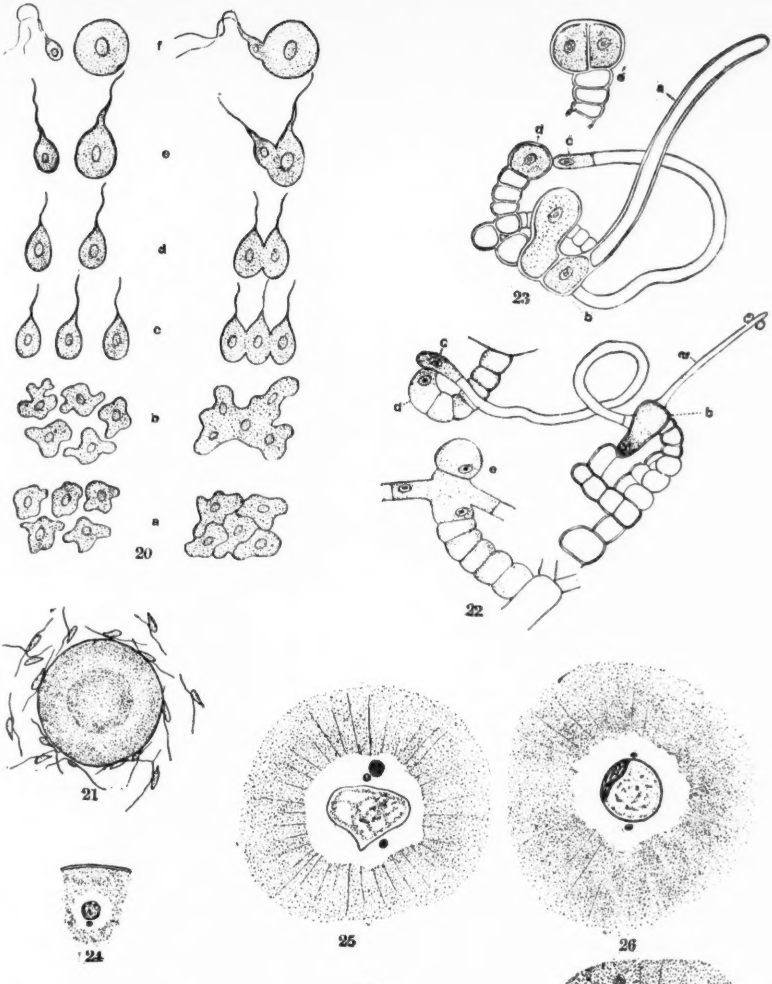
In the above case where the nuclei unite and where the conjugation gives an impulse to further development in the auxiliary cell, which otherwise would have remained quiescent, we have a case fulfilling all the requirements of a true sexual act,—true fecundation, and there seems to be no other way to consider this, than that here we have in the life cycle of the plant, two entirely different sexual acts, one following the other. We are surprised at this unprecedented phenomenon but we can not predicate why it should not occur. The reason for it we may assign to natural selection and development along natural lines. (1) The spores develop at the ends of filaments grown out from the egg cell. (2) The filaments thus formed begin to attach themselves to cells of the branch for nourishment. (3) We find special cells developed which the ooblastema filament finds and unites with in one sense but giving no nuclear union. (4) The ooblastema strikes a specialized cell with which it unites nuclei and protoplasm, the conjugation being complete and the further development from this auxiliary cell. May we not here in the development of the second sexual act of the Red Seaweeds derive a hint as to the physiological meaning of fecundation.

We start in a union for nutrition. We end with conjugation.

FECUNDATION IN ANIMALS.

Character of Ovum.—The animal egg or ovum presents all the characteristics of a normal somatic cell. The rather large nucleus is situated approximately in the centre of the cell, surrounded by abundant protoplasm. The abundant chromatin of the nucleus is arranged as in other cells in the form of a tangled coil like a disordered ball of twine. It is thought by

PLATE XII.



Fecundation and Development.

some, Van Beneden and others, to be continuous, but by Boveri and his followers it is maintained to be interrupted. This matters little, however, as the ultimate division of the coil is into a definite and regular number.

When the egg cell has attained its mature size, a peculiar occurence takes place. The nucleus approaches the wall, forms a spindle and divides, forming at one side of the large ovum a tiny cell, containing half the nuclear matter and a small quantity of protoplasm from the ovum. This is not all, later a second spindle is formed and again the nucleus of the ovum divides throwing off another small cell. These cells thus given off from the ovum are known as *polar globules*. These little bodies, long passed by as of no importance, have by the masterly studies of later authors, foremost among whom are Van Beneden, Boveri and Weismann, been raised to a most important position and are intimately connected with late theories of fecundation.

Minot's Theory of Polar Globules.—What we may term Minot's theory assumes that in the cells both sexes are potentially present. To produce sexual elements the cell divides into its parts; in the case of the egg cell the male polar globules are cast off leaving the female ovum. In parthenogenetic ova he supposes that enough male matter is retained since only one polar globule appears to be formed. Van Beneden is also inclined to regard polar globules as eliminated male matter. Minot's theory then is that in every cell of every organism having sexual reproduction that there is an equal amount of female and of male matter, an equal number of male and of female chromatin bands; and that before the egg can be fertilized, it throws off the male matter that it contains as polar globules, so that the pronucleus consists merely of the female matter, of half the ordinary number of chromatin bands. The spermatozoön which has eliminated all female matter, enters and supplies the required amount of male matter. So that in the fecundated nucleus thus formed we have again the normal number of male and female chromatin segments from the different parents, and this nucleus by its segmentation forms every cell of the new organism. So

from this theory we arrive at an intelligible reason why the offspring comes to resemble both parents but there are difficulties in the way of further tracing heredity which we have not time here to consider.

Weismann's Theory.—Weismann's view is wholly different. He distinguishes in the ovum two kinds of plasm, the germ plasm and the histogenetic or ovogenetic nucleoplasm. The germ plasm which is at first present in the young egg he concludes originates first of all a special histogenetic or ovogenetic nucleoplasm which controls the egg cell up to the point of maturity, enabling it to secrete food material, develop membranes, etc. At maturity this ovogenetic nucleoplasm is of no more use and incapable of retransformation into germ plasm, and is hence thrown off by nuclear division forming the first polar globule. This is all that is extruded in the parthenogenetic ova. The second kind,—his germ plasm,—present in the egg, is that which enables the ovum to develop into an embryo. The second extrusion of a polar globule is a reduction of this germ plasm of the nucleus by half and the same must occur in the male germ cell also. What is thus lost in the formation of the second polar globule, is supplied by the fertilizing spermatozoön. The beginning of development depends, according to this hypothesis, upon the presence of a definite quantity of germ plasm. This the normal egg attains by first losing half and then regaining it; while the parthenogenetic egg attains the same result by never losing any. According to Weismann's view we see that only the second polar globule has to do directly with reproduction and here we have to look for an explanation of reproduction and heredity. As mentioned above Weismann looks upon the second polar globule, by which the germ plasm is reduced one half, as a reduction not only in quantity but above all in complexity of constitution, for by this means, he reasons, the excessive accumulations of different kinds of hereditary tendencies or germ plasms is prevented, which without it would necessarily be produced by fertilization. With the nucleus of the second polar body as many different kinds of germ plasms are removed from the egg as will be afterward added through the sperm nucleus. This

will likely need illustration to make it plain. Suppose we imagine an organism in which sex has just arisen and we thus have fertilization for the first time. In the egg cell resulting from this fertilization we would have mingled the germ plasms of but two parents, or but two kinds of chromatin in the nucleus; the chromatin, be it remembered, being the organ to which all such phenomena are traced. This daughter organism now conjugates with another similar individual which is also but one generation removed from the sexual origin. In the organism resulting from this union we obviously have commingled in the chromatin elements four ancestral tendencies or idioplasms. It is unnecessary to carry this further, obviously the next generation form a similar union, would contain 8 ancestral idioplasms, the next 16, the 10th generation 1024, and so on, doubling each time with every sexually produced generation. It is merely following the well known calculation made by breeders who merely differ in that they use the term blood, half blood or quarter blood, instead of germ, plasm or idioplasms as we have.

While in each succeeding generation the number of germ plasms are doubled, their quantities are reduced by one-half. Thus in a series of generations the continually recurring divisions of the ancestral germ plasms must theoretically ultimately reach a limit. So Weismann argues that the reduction in the number of chromatin bands accomplished by the formation of the second polar globule is to reduce by one-half the number of the ancestral germ plasms in the ovum, and the ancestral germ plasm added by the spermatozoan brings the number of germ plasms in the ovum up to the normal number which he supposes to be present. This theory is of course based on the almost universally accepted theory that fertilization consists in that an equal number of chromatin loops from either parent are placed side by side and form the new segmentation nucleus.

Character of Sperm.—The character of the spermatozoön is familiar to all. It consists of a minute head, composed chiefly of chromatin nuclear matter with a minimum allowance of cytoplasm and a long contractile tail which working behind

like a screw propeller, moves the essential head through the water or along the ducts.

Fertilization consists in a union of the spermatozoön with the ovum. Many devices are developed to bring the two cells near together, but they are then left to conjugate at will, as it were. The road that it is necessary for the spermatozoön to pass over to reach the ovum is frequently quite long, being in the hen about 60 cm. and in large mammifers from 25–30 cm. But they are katabolic little creatures. It is wonderful how such frail creatures can manage to overcome such obstacles. Henle has seen spermatozoa carry along masses of crystals 10 times larger than themselves. Pouchet has seen them carry bunches of from eight to ten blood corpuscles. They have been estimated to carry burdens four or five times heavier than themselves without much difficulty or inconvenience.

Foll's Observations on the Union of Pronuclei.[1]—Herman Foll describes the phenomena of fecundation in the egg of the sea urchin in about the following manner. The spermatozoön five minutes after entering the egg is conical and from its tip a small corpuscle, the spermocenter is detached (fig. 24). The spermatic pronucleus swells and approaches the female pronucleus the spermocentre in advance (fig. 25). The ovocenter is located on the side of the female pronucleus opposite to the side which gave rise to the polar globules. The spermocenter becomes placed at the pole on the side opposite the ovocenter (fig. 26). There are now two prolonged phases the "solar" and the "aureolar;" at the end of the first of these the ovocenter and spermocenter becomes divided in the form of "halters," as the author expresses it, which are not placed in the same plane. These "halters" come to lie parallel to each other in the plane which will be that of the aureole (fig. 27.) In the next phase the spermocenter and ovocenter become divided (fig. 28) and the halves passing in opposite directions along a fourth of a circumference of the combined nucleus arrive at a point at right angles to their previous position. This Foll calls the "Marche du quadrille."

[1]Herman Foll. "Contribution a l'historie de la fècondation," Comptes Rendus Sci. T. cxii (Avril 1891), p. 877.

At the moment when the demiovocenters and demispermocenters are on the point of uniting, the aureole rapidly disappear and true aster become apparent with their perfectly distinct fibrils, much different from the radiations which are visible till then (fig. 29). The demicenters unite and fuse to form the first asterocenters.

The author concludes that fecundation consists not only in the addition of two nuclei arising from different individuals of different sexes, but in the union of two demispermocenters with two demi-ovocentres to form the first two astrocenters. All succeeding astrocenters are derived in equal parts from the mother and father.

Fecundation in Higher Plants.

Development of Embryo Sac and Egg Apparatus:—In the higher plants (the anthophytes or spermophytes) we are particularly concerned with the embryo sac and its inclosed egg apparatus. It is necessary that we should thoroughly understand its development. The embryo sac first shows itself as an enlarged specialized cell in the upper central part of the nucellus or body of the ovule (fig. 30, a). In the maturation the nucleus divides and the two daughter nuclei thus formed travel in opposite directions, one going to the apex, the other to the base of the embryo sac which has, in the meantime, been growing larger and longer (fig. 31). After reaching their respective ends each divide again (figs. 32 and 33) and the two in each end thus formed again divide (fig. 34) forming a tetrad of nuclei at both the apex and the base of the embryo sac. Now a very peculiar thing happens. One of the nuclei from each tetrad thus formed leaves its position and journeys toward the centre of the embryo sac where they come together and fuse, forming the nucleus proper of the embryo sac (fig. 35, c). There is now left at each end of the embryo sac three nuclei of the original tetrad. The nuclei of the upper end become partitioned off by walls and form the egg apparatus proper. The two upper cells, the so-called *synergidæ* or accessory cells (fig. 35, a) are of doubtful function, being merely of secondary value in fertilization. They are some-

times capable, it has been observed, of being fertilized as egg cells and developing embryos (in cases of polyembryony). The lower cell (fig. 35, b) is the egg cell proper. The three basal cells become partitioned off by walls also and are known as antipodal cells; they appear to have no function in fertilization (fig. 35, d).

Development of Pollen:—The pollen or male germ cells are produced in great quantities in the pollen sacs of the anthers. They are formed in mother cells by two successive divisions of the nucleus, thus there are four pollen grains produced in each pollen mother cell (figs. 49 to 55). Later the nucleus of the pollen grains thus formed divides again (fig. 39) forming two cells in the grain, a small and a large one, the so-called generative and vegetative cells. The generative nucleus (fig. 40, b) of the small cell is the one important in fecundation. The vegetative nucleus (fig. 40, a) remains in the pollen grain having no further role in fecundation, or according to Guignard, sometimes passes into the pollen tube in advance of the generative nucleus and follows down the tube as it lengthens, until the micropyle is reached, when it gradually disorganizes and before fertilization takes place has disappeared. At first these two nuclei are separated by a cell wall but sooner or later the wall is broken down allowing the two nuclei to float free in the protoplasm of the pollen grain.

Reduction of the Number of Chromatin Elements in Sexual Nuclei.—Guignard[1] in a late article has emphasized the fact that in sexual cells there is a reduction in the number of the chromatin segments. In somatic cells he finds usually 24 segments, in the sexual cells the number is reduced to 12. In the formation of the young tissue of the anther 24 bands are uniformly present as far as the mother cells, the nucleus of which receives, as have the others so far 24 segments. After the complete differentiation of the mother cell it relapses for a time into a state of repose before the two divisions which are to form the pollen grain. When now the nucleus of the mother cell begins to manifest division it shows all the normal

[1]Guignard, " Sur la Constitution des Noyaux Sexuels ches les Vegetaux, " Comptes Rendus, Soc. de Biol. 22. Mai 1891.—Annal des Sci. Nat. Bot. l. c.

changes of karyokenetic division but when the chromatin segments become visible there are only 12. The 12 segments are found again in the division which succeeds in order to form the pollen grain. Guignard assumes that during the formation of the mother cell the segments have united two and two either end to end or parallel; thus giving only 12. He thinks it certain that this reduction in number can in no way be connected with the elimination of nuclear, matter as seen in polar globules.

In the nucellus of the ovule the nuclei all possess alike 24 chromatin segments. The cell which differentiates to form the embryo sac contains a nucleus which receives 24 chromatin segments but when the nucleus of this divides, after a long state of repose, they show a reduction, as in the pollen, from 24 to 12 segments and these 12 segments are found in all the succeeding divisions in the formation of the egg apparatus. A similar phenomenal reduction is said by Hertwig to occur in the animal kingdom, in the course of development of *Ascaris megalocephala*.

Germination of Pollen and Growth of Pollen Tube:—The act of fecundation proper consists in the union of the male nucleus of the pollen grain with the female nucleus of the egg cell. The mature pollen is transported from the anther where it is formed, to the stigma by the aid of insects, wind, water, etc. We are all, thanks to such men as Darwin and Lobbock, more or less familiar with the various processes by which pollination is accomplished. The pollen brought in contact with the stigma adheres there, being held and excited to germinate by a sticky, sugary exudation which covers the stigmatic surface.

In germination the pollen grain sends out a tube which grows down through the tissue of the style till it reaches the micropyle or entrance to the ovule through which it passes, enters the nucellus or body of the ovule, and comes in contact with the embryo sac, at the upper point where the egg apparatus is situated (figs. 36 and 37). It may well be asked how the pollen tubes in their blind chase downward succeed in finding such a small place as the micropyle and a single

cell in the body of the ovule. How in the inverted ovule they grow downward and then turn and retrace their steps upward; and the same question might properly be asked in regard to the lower plants. How does the antherozoöid of *Fucus* succeed in finding the oosphere which is floating, perhaps, at some distance in the water, or the antherozoöid of a moss plant, the small mouth of the archegonium which is on a different plant. As to this we can only suggest. It has been thought that in such cases the ovum secretes some substance which acts as a chemical excitant on the antherozoöids. Pfeffer working from this suggestion, has surely observed some interesting phenomena, that much strengthen if not absolutely confirm this hypothesis. His method of experimenting was this:—A solution of the substance to be experimented upon was placed in capillary tubes of from 5–7 hundredths of a millimeter wide. These capillary tubes dip into a watch crystal containing liquid wherein quantities of the antherozoids have been placed. Currants of diffusion will, it is seen, start up between the liquid in the capillary tube and that in the watch crystal, and when the substance experimented upon is the right one the antherozoöids are seen to follow the currents of diffusion and enter the capillary tube. In ferns Pfeffer found malic acid or malate to be the effective substance attracting the antherozoöids. As a proof of this, malic acid is found in abundance in prothallium decoctions of ferns and is known to be of very common occurrence throughout the vegetable kingdom. In the moss plant, cane sugar was found to be the effective substance and substances of the closest analogy as glucose, levulose, glycogen, etc., were found to exercise no attraction. Thus Pfeffer formulated an antherozoöid test for these substances, analogous to the bacteria test for oxygen invented by Englemann.

In the growth of the pollen tube from the stigma downward to the embryo sac, a conducting tissue is formed which accomplishes the same purpose. The conducting tissue consists of layers of specialized cells which become filled with nutritive saccharine material and furnishes nourishment to the pollen tube in its downward growth. Frequently we find continuous

tubes, lined by these specialized nourishing cells, leading from the stigma down to the cavity containing the ovules (fig. 38). In this case the ovary contains usually many ovules, frequently an enormous number, many hundreds indeed, so that it is necessary for many tubes to penetrate the style, as it requires one pollen tube to fertilize an ovule and there can be but little doubt but that almost every ovule formed in the ovary, receives a pollen tube and is fertilized. In the orchids one, by careful dissection, can find a silvery bundle of the pollen tubes and trace their progress from stigma to ovule.

In *Yucca* one can easily trace the long continuous tube that leads from the stigma down through the style, in the lower portion of which it branches into three parts, sending one branch into each cavity of the ovary. The pollen tubes may, with but little difficulty, be traced down through the stylar tube to the ovary cavity and found in numerous cases entering the micropyle of the ovules (figs. 36 and 37).

In some cases the irritation produced by the growing pollen tube through the tissue of the style, produces profound changes even before it reaches the egg cell and empties its contents. It has been observed, for instance in orchids, that at the time of pollination the ovules are in a very rudimentary condition and await the stimulus of the growing pollen tube, to develop the egg apparatus and prepare for fertilization. A month after the pollen tube starts its growth, the egg apparatus is completed and not until five weeks after this is fertilization completed. Similar phenomena have been observed in mullein, etc. It must not be thought that fecundation always requires so much time for its consummation, on the contrary it is usually a very quick process, requiring only a few days at most in flowering plants and much less in lower plants where the contact is direct.

Strasburger's Observations on the Immediate Process of Fecundation.—On reaching the embryo sac, the pollen tube hardly proceeds as we would expect. It does not penetrate into the egg cell and then burst leaving a free passage for the generative nucleus. In most cases, at least, it does not even penetrate the embryo sac but the end of the tube spreads out over the

apex of the embryo sac, covering the synergidæ (fig. 37). In some of the lower plants as *Peronospora* where the antheridium develops a conjugating tube, a direct passage is said to be formed by the bursting of the end of the tube which penetrates through the wall of the egg cell (fig. 59). The further process in flowering plants is, acccording to Strasburger, as follows: The nucleus of the generative cell of the pollen grain passes into the pollen tube and just before fertilization may be seen in the apex of the pollen tube surrounded by protoplasm. Before fertilization takes place this generative nucleus divides into two nuclei (figs. 41 and 42) and one of these passes out through the mucilaginous apex of the pollen tube and travels between the disorganized synergidæ to the oosphere. The generative nucleus then enters the oosphere, leaving behind it the protoplasm which had served as a vehicle, and fuses with the female pronucleus. Thus fecundation is completed and is as we see by this outlined process, a fusion of nuclei which would support the view that in reproduction the nuclei are the all important organs. The above description does not consider the exisience of attractive spheres in the vegetable cell and as stated in our consideration of cell division, *Guignard*, followed by others, has lately asserted their universal occurrence accompanying the cell nucleus.

Guignard's Discoveries.[1]—After its introduction into the pollen tube the generative nucleus is fusiform and surrounded by a layer of differentiated protoplasm. The directive spheres, two in number, are generally found at one end of the nucleus. When the generative nucleus divides into two, as explained above, after it has passed into the pollen tube and is located near the apex, the longer axes of the nuclear spindle, is always parallel to that of the pollen tube, hence that one of the resulting reproductive nuclei which is nearest the end of the tube has its attractive spheres preceding it. While the other on the contrary presents them behind the nucleus, where the other pole was situated. *Thus at the moment when the first of these cells, which alone is charged with fecundation, penetrates into*

[1]Guignard, "Sur la Nature Morphologique du Phènomené de la Fècondation." Compt. Rend. de Biol. 9 Ser. T. III (1891) p. 467.—Annal. des Sci. Nat. Bot. l. c.

the female apparatus the two directive spheres which it possesses precede it.

In the embryo sac, as explained above, one stage shows the nuclei disposed in two tetrads, one at the summit and the other at the base. In the apical tetrad the nuclei which belong to the synergidæ are formed by a horizontal division (figs. 43 and 44) and their attractive spheres, therefore, occupy their lateral faces. The two other nuclei on the contrary are originated in a perpendicular plane (fig. 43). Thus the nucleus which goes to form the oosphere, has its two attractive spheres above it (figs. 44 and 45, *b*) while the other that travels to the centre of the embryo sac to fuse with a similar one from below, has its attractive spheres below it. (Upper nucleus, fig. 44, *c*.

The male nucleus, which is strongly contracted in its passage into the egg cell, increases in size and forms what is now termed the male pronucleus which is preceded, it will be remembered, by its two attractive spheres (fig. 45, *d*). The contact first occurs between the attractive spheres. These coalesce two by two, male sphere with female sphere (fig. 46). They then separate from each other so as to allow the male and female pronuclei to pass between them and fuse (fig. 47 and 48). The male pronucleus unites with the female pronucleus and remains thus in contact but is clearly distinguishable until the first segmentation starts. In each couple, formed by the union of male and female attractive spheres, the fusion takes place slowly. When thoroughly fused fecundation is complete. The two new spheres thus formed will be the origin of the poles of the first segmentation spindle. Before the first division they orient themselves in such a fashion that this spindle will be parallel to the longitudinal axes of the egg cell. *It results, from these observations, that the phenomena of fecundation consists not only in the copulation of two nuclei of different sexual origin but also in the fusion of two protoplasmic bodies of equally different origin.*

The process of fecundation in the sea urchin, explained above from Foll, agrees chiefly with this. Differing only in that the attractive sphere does not divide until it enters the egg.

Polar Globules in Plants.—Have we now anything in the

maturation of the egg cell and the antherozoids that correspond to polar globules in the animal egg? In short, it is thought that we find analogous exudations of nuclear matter almost universally in plants. In the development of the planogametes of *Ulothrix* a portion of waste protoplasm is extruded with the planogametes containing probably the extruded nuclear matter.

Among the well differentiated female gametes, it is said, *Peronospora* affords an excellent illustration of what we may term polar globules. In the development of the oosphere, according to Wagner, the numerous nuclei which at first are scattered uniformly throughout the oogonium (fig. 57) at length approach the periphery leaving the central portion of the oogonium occupied by large vacuoles, and a small central mass of protoplasm connected with the periphery by protoplasmic strands. The nuclei now limited to the periphery further divide and 2 or 3 (?) finally leave the periphery and approach the central mass of protoplasm traveling along the connecting protoplasmic strands and supposedly unite in the centre, forming the nucleus of the oosphere (fig. 58). While these nuclei are thus traveling toward the centre, the cell wall of the oosphere begins to form, separating the central mass of protoplasm with its two nuclei from the peripheral or *periplasm* with its numerous nuclei, some of which are supposed to be used up in the formation of the oosphere wall. The nuclei thus relegated to the periplasm have been considered as of the nature of polar globules. But with the present light on the subject it must remain surely as a very doubtful and indefinite case.

In the development of the antherozoöids of ferns, when the antherozoöid is set free there is attached to its posterior end an appendage which is usually described as a protoplasmic vesicle, but Dodel-Port and Belajeff think it to contain nuclear matter also from the mother cells.

In flowering plants the nucleus of the pollen divides into two cells (figs. 39 and 40) a vegetative and a generative. The vegetative is thought by Strasburger to have the function of a polar globule. Again the generative

nucleus after it has passed down the pollen tube divides, and only one portion enters the oosphere (figs. 41 and 42), the other remaining as waste nuclear matter and may be considered as a second polar globule. In the development of the embryo sac it is thought the division of the nucleus which gives rise to the nucleus of the egg cell and of the polar nucleus which travels to the middle of the embryo sac to fuse with a similar one from the basal tetrad, is one of the divisions sought and that the polar nucleus has in reality the significance of a polar globule. If a second polar globule is formed it is likely the preceding division, that which gives rise to the first of the synergidæ. If this is the case the regular after division that forms the two synergidæ may be looked upon as corresponding with the rather abnormal but quite frequent division which occurs in the first polar globule of many animals.

The instances cited of polar globules in the vegetable kingdom, it will be seen, do not possess that definiteness that is found in the animal kingdom. We fain would have greater definiteness but further work is here necessary. Doubt clusters about many questions connected with fertilization. We must be content to take things as they are even if somewhat unsatisfactory, until further investigation throws light on the obscure points.

Shaw School of Botany.

December 16, 1891. St. Louis, Mo.

EXPLANATION OF PLATES.

The figures are mostly redrawn or adapted from various standard investigations. A few are original.

PLATES XI–XIV.

Fig. 1. A portion of the frond of *Caulerpa*, natural size. (Redrawn from Sachs.' Phys. of Plants, Eng. Ed. p. 492.

Figs. 2–9. *Iris pumila.* Dividing mother cell of a stoma. (Redrawn from Strasburger "Zellbild. und Zellteil." (3rd. Ed. 1880.) Pl. viii). Fig. 2. Resting nucleus. 3. Contraction and breaking up of the nuclear thread. 4. Nuclear spindle. 5.

Separation of chromatin segments. 6. Fusion of chromatin segments at each pole.. 7 and 8. Organization of the daughter nuclei and formation of the cell plate. 9. The two resulting daughter nuclei.

Figs. 10–11. (Redrawn from Watase.—"Karyokenesis" Biological Lectures p. 168). Fig. 10. Nucleus dividing, showing archoplasmic spheres; (*a*) centre of archoplasm; (*c*) cytoplasm. Fig. 11. Division of the archoplasmic sphere.

Fig. 12. (Original). Diagramatic outline of nuclear division modeled from Guignard's description; (*a*) centrosome surrounded by a hyaline circle; (*b*) surrounding granular circle; (*c*) cytoplasm.

Fig. 13. (Original). Diagramatic outline of the development of the *Acrasieæ*; (*a*) spore; (*b*) escaping mass of protoplasm; (*c*) swarm spore; (*d*) swarm spore preparing for division; (*e*) dividing swarm spore; (*f*) completion of the division; (*g*) plasmodium; (*h*) sporangium.

Fig. 14. (Original). Diagramatic outline of the plasmodium formation, etc. in *Myoxomycetes*; (*a*) swarm spores; (*b*) starting of fusion; (*c*) plasmodium; (*d*) sporangium.

Figs. 15–16. (Redrawn from Strasburger Bot. Zeit. xxxv, (1877) Taf. xiii, fig. 14, f. and i.) Multiple conjugation of the zoospores of *Acetabularia mediterranea.*

Fig. 17. (Redrawn from Dodel-Port in Vines. Phys. Bot. p. 606) Planogametes of *Ulothrix,* one free, others in conjugation.

Fig. 18. (Redrawn from Strasburger) Reproduction of a moss plant; (*a*) archegonium with enclosed egg cell; (*b*) antherozoöid.

Fig. 19. (Redrawn after Berthold in Binet's Psychic Life of Micro-Organisms p. 84) Planogametes of *Ectocarpus siliculosus.* (*a–c*) Differentiation of female planogamete; (*d*) female planogamete surrounded by males; (*e–h*) process of conjugation.

Fig. 20. (Adapted from Geddes and Thomson in Evolution of Sex.) Diagram of the course of development of fecundation. (*a*) Adhesion of swarm spores into plasmodium, ex. *Acrasieæ*; (*b*) fusion of swarm spores into plasmodium, ex. *Myxomycetes*; (*c*) multiple conjugation of planogametes, ex. *Acetabularia*; (*d*) conjugation of two planogametes, ex. *Ulothrix*; (*e*) conjugation of dimorphic notile cells, ex. *Cutleria*; (*f*)

fecundation proper of egg cell by antherozoöid, ex. *Moss Plant.*

Fig. 21. (Redrawn from Thuret in Bessey's Bot. p. 267). Oosphere of *Fucus vesiculosus* surrounded by spermatozoids.

Fig. 22. (Adapted from Schmitz Ann. and Mag. of Nat. Hist. vol. xiii, Ser. 5, (1884) Pl. 1, figs. 16–19) *Dudresnaya purpurifera.* (*a*) Trichogyne with adhering spermatia; (*b*) egg cell; (*c*) conjugating cell cut off at end of ooblastema filament; (*d*) auxiliary cell; (*e*) later stage after conjugation of auxiliary cell and ooblastema filament.

Fig. 23. (Adapted from Schmitz, l. c.) *Glœosiphonia capillaris,* (letters as in fig. 22.)

Figs. 24–29. Redrawn from Foll, Comptes Rendus l. c.) Fecundation of the egg of the sea urchin.

Figs. 30–35. (Redrawn from Strasburger, Zellbild, und Zellteil, 3 Anflage, Pls. iv and v). Development of the embryo sac and egg apparatus of *Monotropa hypopitys.* Fig. 30. Nucellus with embryo sac; and (*a*) its primary embryo sac nucleus. Fig. 31–34, enlargement of embryo sac and formation of the two apical tetrads of nuclei. Fig. 35. (*a*) synergidæ; (*b*) egg cell; (*c*) the two nuclei, one from each tetrad that fuse forming the nucleus proper of the embryo sac; (*d*) antipodal cells.

Fig. 36. (Original). Camera sketch of a longitudinal section of the pistil of *Yucca angustifolia*, x. about 5 diam. Showing the continuous styler tube with numerous pollen tubes running down to the ovules.

Fig. 37. (Original). Camera sketch, x. 400 diam. of the ovule of *Yucca angustifolia,* showing one ovule coat, the nucellus, the embryo sac with its enclosed egg apparatus, and a pollen tube; (*e*) that has entered the micropyle of the ovule and penetrated to the embryo sac.

Fig. 38. (Original). Conducting tissue. Cross section of the style of *Yucca augustifolia.* Camera sketch, x. 150 diam.

Figs. 39–42. (Redrawn from Strasburger Befrucht. bei den Phaner. Taf. 1.) Fig. 39. Young pollen grain during division into generative and vegetative cells. Fig. 10. Mature pollen grain; (*a*) vegetative nucleus; (*b*) generative nucleus. Figs. 41 and 42. Portions of the pollen tube with the generative nucleus in division.

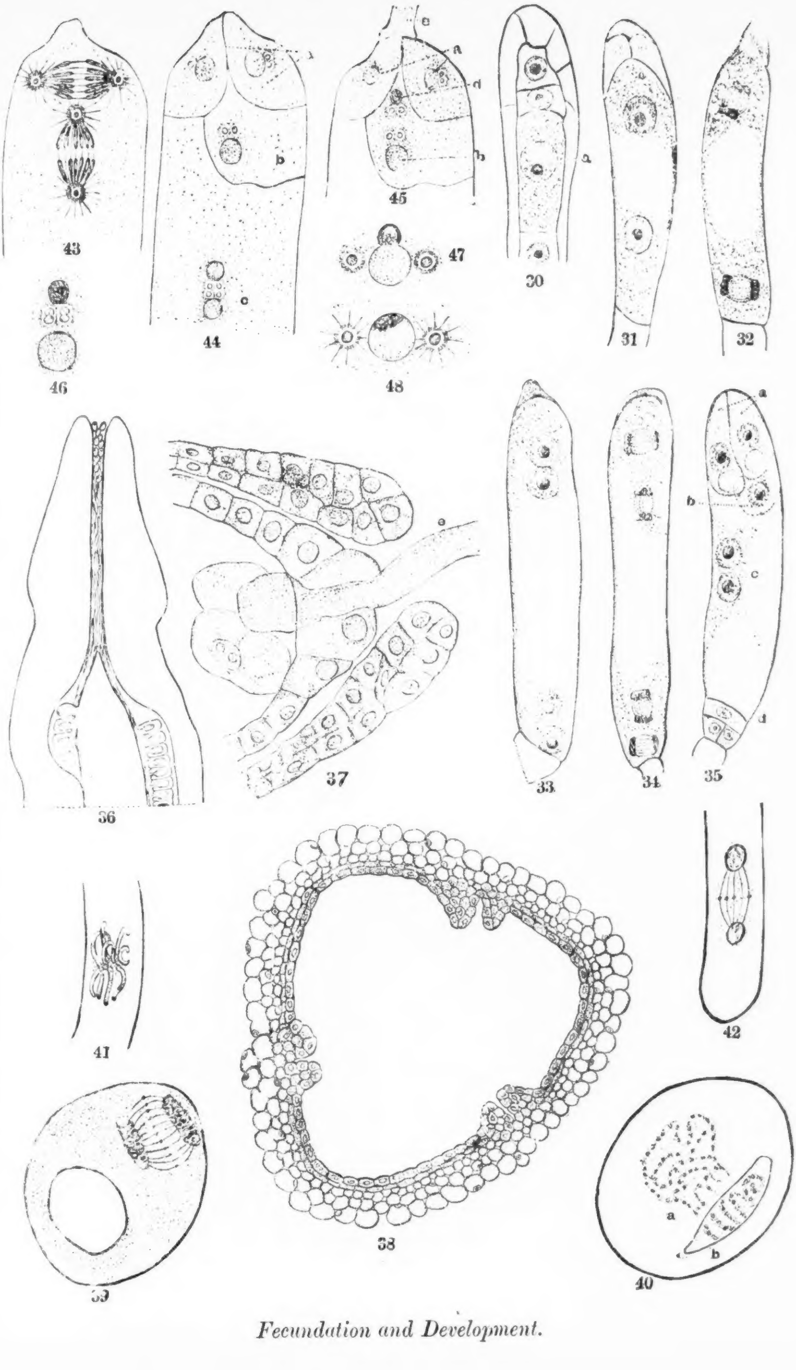
Figs. 43–48. (Original). Diagramatic outlines of embryo sac and nuclear changes during fecundation modeled from Guignard's descriptions. Fig. 43. Division of nuclei to form the upper tetrad, showing asters centrosomes, etc. Fig. 44. (*a*) synergidæ; (*b*) oosphere; (*c*) union of nuclei to form the nucleus of the embryo sac. Fig. 45. (*a*) nuclei of the synergidæ; (*b*) nucleus of the oosphere; (*d*) male pronucleus preceded by its directive spheres; (*e*) pollen tube. Fig 46. Union of the male and female directive spheres. Fig. 47. Separation of the directive spheres and union of nuclei. Fig. 48. Fecundated nucleus ready for the first segmentation, the male portion is still distinguishable (the male nucleus in the last three colored dark).

Figs. 49–56. (Redrawn from Guignard, Annal. des Sci. Nat. Bot. Se. 7, T. xiv, Pl. 10). Formation of the pollen grains in a pollen mother cell of *Lilium martagon.* Fig. 49. Mother cell in resting stage showing chromatin band, nucleolus (paranucleolus) and two directive spheres. Fig. 50. Rupture of chromatin filament into 12 segments. Fig. 51. Division (longitudinal) of these segments. Fig. 52. The nuclear spindle in profile. Fig. 53. Separation of the daughter segments and division of the directive sphere. Fig. 54. Two cells in the resting stage, completion of the first division. Fig. 55. Division of these two cells to form the four pollen grains. Fig. 56. One of the young pollen grains of the last division in a resting stage before the division which gives rise to the vegetative and generative nuclei. (See Fig. 39.)

Figs. 57–59. (Redrawn from Wagner, Ann. of Bot. vol. iv, Pl. vi.) Fecundation of *Peronospora parasitica.* Fig. 57. Oogonium with antheridium at one side. Fig. 58. Formation of oosphere, two nuclei approaching the centre to unite. Fig. 59. Mature oosphere in process of fecundation, showing the antheridial tube grown through the oogonium to the oosphere.

Fig. 60. (Adapted from Geddes and Thomson, l. c.) Diagram illustrating effect of environment on an amœboid cell. On the left, when subjected to preponderating katabolism, *yielding antherozoöid.* On the right when subjected to preponderating anabolism, yielding oosphere. Medium conditions indicated by the central line of amœboid cells.

PLATE XIII.



Fecundation and Development.

RECORD OF NORTH AMERICAN ZOOLOGY.

BY J. S. KINGSLEY.

(Continued from Vol. XXV., page 989.)

ARTHROPODA.

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EDITORIALS.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

—It is to be hoped that the alleged intention of the Postmaster-General to unify the system of names of post-offices in the United States may be carried into effect. The poverty of inventive capacity of our people in the matter of the giving of names is remarkable. Many places in the Eastern States are named from localities in the Old World, from which the early immigrants came. This is objectionable, but it is tolerable so long as the duplication shall go no farther. Such naming as was practiced by the early inhabitants of the State of New York was less excusable, since no bond of local affection was the motive for ransacking the ancient geographies and dumping their contents broadcast over the wilderness. But now we meet with duplication after duplication springing up in all the States, south and west of the Alleghanies. The settlers and builders of new towns seem to imagine that to give a name which is not already on the map or in a book reflects on their intelligence and knowledge of geography; so that new Manchesters, Birminghams, Troys, Romes, Athenses, Springfields, etc., etc., are springing up with a rapidity that is confusing to the mind and destructive to any correct knowledge of the whereabouts of such places. A little reflection will convince any persons desirous of naming a new town or post-office that one of the most efficient ways of advertising a place is to give it a name unlike any other; and moreover that by so doing much trouble in the matter of future mail delivery will be spared them.

A majority of our naturalists who have naming to do exhibit the same deficiency. They frequently encourage foolish naming of localities by naming species after them. If such local names are changed hereafter the scientific names founded on them will be left high and dry. But the least excusable form of scientific name is that which is taken from a locality whose name is already a duplicate of one in the Old World. Who ever heard of Naples in New York? Yet a paleontologist has recently named an important fossil *Clymenia neapolitana,* which is found in the "Naples shale," in Western New York. Another has with equal absurdity named a species from Minnesota *Camarella bernensis.* A geologist names a glacial beach the Leipsic

beach. There should, of course, be no such names as Naples, Berne or Leipsic in America; but as they are there, it is a conspicuous gaucherie that scientists should seek to preserve them in nomenclature. Science is cosmopolitan, and the law of priority should apply to local names as well as to anything else. It is to be hoped that the time will come when a rule will be added to those in our code, that no name shall be given from a locality whose name had a previous existence in some other part of the world.

—We have received a circular from a distinguished member of National Academy of Sciences which suggests that the number of members of the Academy be reduced to seventy. The number of one hundred does not seem to be excessive if we consider the probable future of our country, but an increase in the number is clearly inadvisable. The proposed reduction seems to us equally so. The change most needed is one which shall designate classes of members and thus keep deficiencies more clearly before the Academy. Four classes were proposed several years ago, with the following proportions: Of the 100, 35 to represent inorganic science (Sec. A); 35 to represent organic science (Sec. B); 15 to represent mental and mathematical science (Sec. C); and 15 to represent applied science (Sec. D).

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WOOLMAN, L.—Artesian Wells and Water Horizons in Southern N. J., and their Relation to an Immense Diatomaceous Clay Bed. Ext. Ann. Rep. State Geol., 1890. From the author.

RECENT LITERATURE.

Some Recent Zoological Text-books.—In the last few years German zoologists have produced a considerable number of handbooks, manuals and compendiums of zoology and its various subdivisions, the majority of which have been issued from a single publishing house, that of Fischer of Jena. The first requiring mention is the zoology[1] by Boas of Copenhagen. This is in reality a second edition of the Danish work of 1888, and the author acknowledges the assistance received from Prof. Spengel in making the translation. It differs from the original in many respects, the most noticeable being an added section, entitled "Biologie." The work is divided into two portions, general and special, occupying respectively 90 and 475 pages. In the first occur those general statements regarding cells, tissues and organs, the relation of animals to their environment, and the outlines of the theory of evolution; which are deemed indispensable in the ordinary text-book. In the special portion the various groups of the animal kingdom are discussed. As must occur in a work by a single author there is considerable inequality in the treatment, while a rather reprehensible practice (not however confined to Dr. Boas) of treating certain groups as appendages (Anhangen) of others result in some rather queer associations. To show the scope and views of the author, an outline of the classification followed is here given. 1, Protozoa; 2, Cœlenterates, with the sponges as an anhang; 3, Echinodermata; 4, Plathelminthes (including Nemertines) with the Rotifers as an anhang; 5, Nemathelminthes; 6, Annelida, with the Gephyræa as an anhang to the Chætopods and separating them from the Hirudinei, and with Polyzoa and Brachiopods as an anhang to the whole group; 7, Arthropoda divided into Crustacea, Myriapods, Insecta and Arachnids; Limulus being inserted between Cladocera and Ostracoda, the Stomatopoda following the Decapods; and Peripatus serving as an anhang to the Myriapods; 8, Mollusca, arranged as follows: Chitons, Gastropoda, Acephala, and Cephalopoda, the Pteropoda being closely associated with the Opisthobranchs; 9, Vertebrata, divided into Leptocardii, Pisces, Amphibia, Reptilia, Aves, and Mammals, while the Tunicata occupy the last four pages of the volume of the work, as an appendix to the Vertebrates. The work of Boas, as a

[1]Lehrbuch der Zoologie für Studirende und Lehrer, Dr. J. E. V. Boas, Jena, 1890, pp. 578.

whole seems well adapted to replace the well-known "Lehrbuch" of Claus. It is possibly not so satisfactory in its treatment of the invertebrates, but in the vertebrates, as one would expect from Dr. Boas' reputation, it far surpasses the latter. Its smaller size is distinctly a recommendation in its favor. The illustrations, 378 in number, are largely diagrammatic, but are not very artistic.

The fifth edition of Claus's Lehrbuch[2] has been subjected to only a very cursory examination. The additions (92 pages and 77 cuts) are considerable but they seem to be mostly of minor importance, while the many glaring faults of the previous edition are left unaltered. Possibly a more thorough examination would show that the improvements were commensurate with the increase in size.

It is greatly to be regretted that the zoology of Hatschek[3] show but slight chance of completion, for while the work is scarcely adapted for the students of the grade of those in our colleges, it is certainly so far as it goes, most suggestive to the more advanced morphologist. That very wealth of theory, which spoils the work for the beginner, opens up new vistas to his instructor. Yet, if it never be completed, it will long have its value for the student, just as has the still uncompleted vertebrate volume of the Handbuch der Zootomie of Stannius. An analysis of the work is next to impossible in its uncompleted condition.

One familiar with Schmidt's small Comparative Anatomy would never recognize it in Lang's new edition,[4] in which, to our minds all reference to the previous editions should be omitted. The two parts which have already appeared discuss those groups which are usually included under Protozoa, Cœlenlerates, Worms, and Arthropods; and here as in Hatschek's work, the subject is allowed to logically develop itself, there being no distinction between general and special portions. Thus in Lang's work there are first a few words upon the cell and then the account of the unicellular animals, the tissues and organs of the many-celled forms being described and elucidated later as the occasion demands. Between Hatschek's and Lang's works there are

[2]C. Claus. Lehrbuch der Zoologie. 5 Aufl. Marburg, 1890, pp. xii, 958, xx.

[3]Lehrbuch der Zoologie, eine morphologische Übersicht des Thierreiches zur Einführung in das Studium deiser Wissenschaft von Dr. Berthold Hatschek. Erste bis dritte Lieferungen Jena, 1888-1891, pp. iv, 432.

[4]Lehrbuch der vergleichenden Anatomie zum Gebrauche bei vergleichend anatomischen and zoologischen Vorlesungen von Dr. Arnold Lang. Neunte gänzlich umgearbitete Auflage von Edward Oscar Schmidt's Handbuch der vergleichenden Anatomie. Erste und zweite Abtheilungen. Jena, 1888-1890, pp. iv-566.

many contrasts. Where Hatschek is brilliant, Lang is conservative; Hatschek gives generalizations; Lang offers a mine of detail; Hatschek has many novelties in classification; Lang follows rather the beaten track. In short Lang's work stands to-day the most useful compendium of invertebrate anatomy in existence. When the other portions are finished (which we learn from the author will be in about two years) the whole will take a front rank among the text-books of the world.

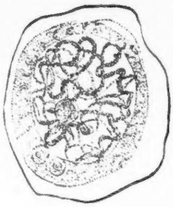
Another work of somewhat different scope which deserves praise as high as Lang's Anatomie, is the Comparative Embryology of the Invertebrates[5] of Korschelt and Heider, of which two parts have already appeared. In opening a work of this character one naturally compares it with the classic work of Balfour, issued ten years ago. Until the whole work is completed a satisfactory comparison cannot be made, for while Balfour scattered many of his generalizations through the accounts of the different groups, the young Berliners reserve more for the special portion which has yet to appear. It is interesting to compare the size of the two volumes in some detail as follows, keeping in mind the fact that the page of Korschelt and Heider contains about 25 per cent more than that of Balfour.

	Balfour.	Korschelt & Heider.
Sponges	12 pages.	18 pages.
Cœlenterates	31 "	84 "
Annelids	38 "	65 "
Other "worms"	47 "	80 "
Enteropneusti	4 "	11 "
Echinoderms	31 "	50 "
Arthropoda	137 "	600 "

This conveys some idea of the amount of literature which has been boiled down into these two parts, for they must be regarded rather as compilations than as philosophical works; the philosophy is to come later. We learn that the concluding part will include the Molluscs, the Tunicates, Balanoglossus and Amphioxus, in other words all that are not in the strictest sense vertebrates; as well as the general portion, and that a year or two more must elapse before the whole is completed. Thus it, together with the somewhat older Lehrbuch der Entwick-

[5]Lehrbuch der vergleichenden Entwicklungsgeschechte der wirbellosen Thiere von Dr. E. Korschelt and Dr. K. Heider. Specieller Theil. Erstes und zweites heften. Jena, 1890–91, pp. xii–908.

PLATE XIV.



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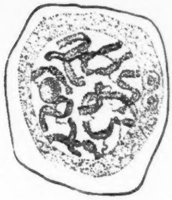

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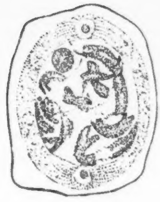

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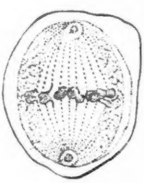

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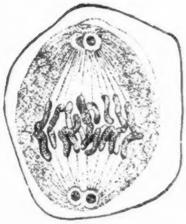

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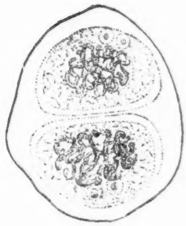

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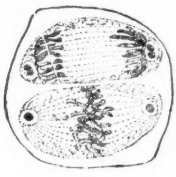

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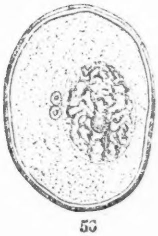

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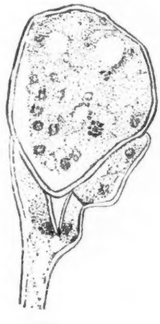

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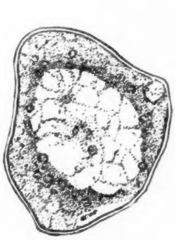

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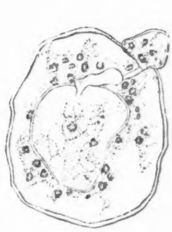

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Fecundation and Development.

lungsgeschichte of Oscar Hertwig, will form a compendious account of Embryology as it is understood to-day.

Last in our series comes the Zoology[6] of Richard Hertwig, of which the second and concluding portion is promised immediately. From the reputation of the author and from the compact size of the volume we had hoped for much in this work, but to us it seems far less satisfactory than any of the other works enumerated. All of the others bear abundant evidence of careful preparation but this shows on every page haste and carelessness. This shows itself not only in matter but in typographic arrangement. Thus the chapter on the Development of Systematic Zoology is made of equal rank to the section headed "History of Zoology." On the textual side adverse criticism is easy. Thus the account of the theory of evolution, though nearly thirty pages in length, contains no mention of the post Darwinian labors. Ten pages are devoted to the cell and cell division but no mention is made of the part played by the centrosome. The account of coral formation (p. 210) is unintelligible and misleading. The Narcomedusæ are ignored. A lack of proportion is everywhere noticeable. Thus the Protozoa have 33 pages accorded them, while the Annelids have but 12. These are but samples. The book, on the other hand has its good features. We have been pleased with the concluding portions of each section, entitled "Zusammenfassung der Resultate," where in categorical form the author has brought together in condensed shape the most important facts regarding the group, and which might almost be used for a syllabus of lectures.

The text-books which have been mentioned are all in German, but two of them are announced for English translation—Korschelt and Heider's Embryology and that of Oscar Hertwig, while a portion of Lang's Anatomy has already been issued. With this German zoological vitality the English language offers nothing in comparison. No text-book has been issued from England or America in the last five years and the long advertised zoology by an English zoologist will hardly appear for five years to come. But Germany still puts out new books and new editions. In the early future we are promised a new Comparative Anatomy by Gegenbaur, new editions of both the "Lehrbuch" and the "Grundriss" of Comparative Anatomy by Wiedersheim, while Prof. Lang of Zürich is contemplating an abridgement of his Comparative Anatomy as soon as the larger work is complete. The proposed edition of Balfour's Comparative Embry-

[6]Lehrbuch der Zoologie von Dr. Richard Hertwig, Erste Theil. Jena, 1891, pp. 320.

ology revised to date is abandoned for the present, while a new work on the Embryology of the Vertebrates, by Dr. C. S. Minot will appear at an early date.—J. S. KINGSLEY.

Stanislas Meunier's[7] "Les Methodes de Synthèse eu Minéralogie" is a monumental work worthy alike of the author who wrote it and of the subject of which it treats. Nearly all books on the artificial production of minerals that have heretofore appeared have been simply lists of products obtained in the laboratory, classified under the titles of the natural products with which they are identical. In the present volume a notable improvement has been made in the method of presenting that most fascinating of all mineralogical problems—the manufacture of minerals and the bearing of the processes involved therein upon the great geological questions relating to metamorphism, the production of mineral veins and the formation of ores. Instead of briefly mentioning the different methods by which the several minerals have been obtained, the author discusses the methods themselves, and illustrates them by citing the many products which each yields. He then points out the manner in which the processes throw light on the origin of mineral names in the earth's crust, and shows the relations existing between them. The study of chemical geology must receive a new impetus if the volume before us is made of as much use as it deserves to be. Geologists will thank the author for the suggestive hints that are so abundant throughout his book; mineralogists will welcome the appearance of a volume that so clearly describes the processes by which so many interesting minerals have been manufactured; chemists, if they will only think so, may find given in the treatise many reactions that will help to clear up the difficult problem of the constitution of inorganic compounds, and so will join with the mineralogists and the geologists in according the work a hearty reception.

The historical method of development of the subject is followed in most instances. After classifying the methods that have been employed by the many workers in this field, Meunier begins by giving a very detailed account of the different processes as they were first used, and then mentions their modifications, in each case referring briefly, or at length, as occasion demands, to the minerals yielded by each. Before taking up the subject proper of the work, the author describes the conditions under which minerals are being formed at

[7]Paris, Baudry et Cie, 1891, pp. xii and 359.

present in various portions of the earth, and follows these with an account of the accidental syntheses that have been reported, such as those resulting during the burning of coal under ground, or those produced by action of the moisture of the soil upon coins buried in it, etc. He then comes to the subject proper of the book—an account of the 'rational syntheses' that have been made. He gives an account of all the minerals formed by dry fusion, with or without the intervention of a 'mineralizer,' describes the wet methods that have yielded products identical with minerals, and discusses the mixed processes that have given similar results. The classification of methods is simple and at the same time satisfactory. So far as the reviewer is able to judge, nearly all mineral syntheses that have ever been made are at least referred to in Meunier's book.—W. S. BAYLEY.

The Worms of Bronn's Thier-Reichs.—This volume was commenced by A. Pagenstecher who wrote "Lieferungen 1–6" and was then obliged to give up further work on account of ill-health. Prof. Max Braun[8] of Königsburg (i, Pr.), Germany has undertaken the task of completing the treatise and up to date has issued Lief. 7–16.

Lief. 1–7 are given up to a historical introduction (261 p.), while the remainder of the work which has thus far appeared is occupied with a discussion of the Mionelminthes and Monogenea.

The system thus far adopted is:

MIONELMINTHES: I. Rhombozoa, 1. ord. Heterocyemida (genera *Conocyema, Microcyema*), 2. ord. *Dicyemida* (genera *Dicyema, Dicyemennea*). II. Orthonectida (g. *Rhopalura*). *Trichoplax.*

PLATHELMINTHES: I. Trematodes, 1. Monogenea; families: Temnocephaleæ, 1 genus; Tristomeæ, 3 sub-families with 14 genera; Polystomeæ, 4 sub-families with 18 genera. (It will be noticed that Braun does not use the ending *idæ* determined upon by the International Congress as the ending of the family name).

The work is well written, finely illustrated and contains a very full bibliography with short reviews of every paper. This book will be the most complete treatise in existence on the group Vermes, and is indispensible to those who wish to work in that subject. The Reviewer urges all Americans who publish on the group, to aid Prof. Braun in the rest of his work by forwarding to him reprints of all the papers they publish in this line.

The monograph costs 1 mark 50 pro Lieferŭng, and is published by C. P. Winter, Leipzig and Heidelberg.—C. W. STILES.

[8]Braun's Klassen und Ordnungen des Thier-Reichs: Bd. iv. Vermes.

General Notes.

GEOLOGY AND PALEONTOLOGY.

The Eocene of the United States.[1]—The present essay is the fourth of a series devoted to the discussion of the correlations of the formations found in the different parts of the country with one another, and with formations in other countries; and to the discussion of the principles of geologic correlation in the light of American phenomena. Mr. Clark thus describes the scope of the work.

" This essay comprises, first a general discussion of the limitation of the term Eocene as employed in American geology. The two-fold character of the Tertiary (1. Eocene, 2. Neocene) in America is insisted on.

After a somewhat extended review of the literature, in which the various opinions upon disputed points are especially considered, a general study of the Stratigraphical, paleontological, and topographical characteristics of the Eocene in the various portions of the country is undertaken.

The description of the Eocene of the United States falls naturally into the three distinct regions, viz: The Atlantic and Gulf Coast region ; the Pacific Coast region, and the interior region.

Following a study of the stratigraphical relations of the Eocene of the Atlantic and Gulf Coast region, an attempt is made to correlate the very diverse formations of this great area. Four provinces are provisionally established (1. New Jersey province, 2. Maryland-Virginia province, 3. Carolina Georgia province, 4. Gulf province,) though fuller knowledge may break down their bounds. The general similarity of the deposits and their fossils to extra-American Eocene is shown, but detailed correlation is not considered feasible.

The meager knowledge of the Pacific Coast Eocene precludes any general discussion of the stratigraphical and paleontological relations of that horizon. The local peculiarities, shown both in fossils and deposits, are referred to, and the close relationship existing between the Eocene and Cretaceous is dwelt upon. Their separation is a matter of some uncertainty with our present information. Certain

[1]Bulletin of the United States Geological Survey, No. 83, 1891. Correlation papers. Eocene. William Bullock Clark.

points of identity with Eocene deposits elsewhere are mentioned. Two groups of strata are recognized, one marine (Tejon group), the other brackish (Puget group).

The remarkable conditions under which the deposits of the Interior region were accumulated and the interesting fauna and flora that they afford are fully discussed in the final division of the essay. The general relations of the fauna and flora of the Eocene of the interior to that of other regions is pointed out, though no attempt is made at a detailed correlation of its various members. The Laramie problem, although more fully presented by Dr. White in his paper upon the Cretaceous, is here referred to, and the facts are given which are said to show that the Laramie is in part Eocene. The conflict between the evidence afforded by animals and plants is stated with the consequent hindrance to satisfactory correlation.

Dr. Clark incidentally to the subject gives a historical discussion of the Laramie formation which he finally excludes from the Eocene series. This discussion is of much interest as showing the growth of opinion based on accumulating evidence. He might have been a little more explicit in his reference to the first determination of the Cretaceous age of the Laramie formation. He says, (p. 114), "Prof. E. D. Cope (Amer. Philos. Soc. Trans. xiv, 186–9, pp. 1–252) raises a doubt concerning the Tertiary age of the entire lignitic series ...... by mentioning *Ischyrosaurus antiquus* Leidy from the 'Great Lignitic' of Nebraska as perhaps of Cretaceous age, and *Hadrosaurus ? occidentalis* Leidy from the 'Cretaceous beds of Nebraska,'" etc. There was however more than the "raising of a doubt" expressed in the memoir by Cope thus quoted. He says, p. 98; "..... I instituted an examination of the forms brought by Dr. Hayden from this locality [Nebraska] and first of that most characteristic animal the Ischyrotherium of Leidy. This, as has appeared on the preceding pages I believe to be a reptile allied to Plesiosaurus, a conclusion which *at once establishes Mesozoic age of the bed.* It coincides with the presence of Hadrosaurus in indicating Cretaceous or upper Jurassic age."

We observe with surprise that Dr. Clark does not include the Plistocene in the Cenozoic series. We suppose he would relegate this age to a distinct realm, the so-called Quaternary. But the propriety of such a classification has, in our opinion yet to be shown.

Dr. Clark remarks (p. 16); "the term Eocene which is retained as equivalent to Lower Tertiary, may or may not coincide with the division so designated by European geologists." We would suggest then why adopt the term Eocene at all? One is led to suppose from

this and the paragraph preceding it that the term had been originated by the U. S. Geological Survey. The article then goes on to say; "the attempt at a detailed correlation of American formations with European, so often made in the past on insufficient data, is greatly to be deprecated." This is the language of a stratigrapher, but not of a paleontologist. The correlation of horizons the world over is one of the *raisons d'etre* of the science of geology, and it is chiefly to be accomplished by the aid of paleontology. The paleontologic correlation of the American Wasatch with the French Suessonien for instance is so clear, that some day, in a comprehensive system they may be called by the same name. Various other cases are equally clear. In fact the language quoted is the expression of a chauvinism which has been characteristic of the U. S. Geological Survey, but which we hope it will outgrow. A favorable symptom is the very full consideration given to the work of its predecessors in America, as exhibitep in this able monograph by Prof. Clark.

In conclusion, an alphabetical list of the leading articles upon the Eocene of the United States is presented.

A Florida Lake Basin.—In a recent letter from Gainsville, Florida, Mr. Henry Bomford gives the following description of an interesting phenomenon:

"There is a prairie within three miles of this place that is fifteen miles in length, with an average width of five miles. Twelve years ago it filled with water to a depth of eight to twenty feet, varying according to high and low ground. This water stood undisturbed for this twelve years space of time until last August, when it suddenly disappeared in two days, leaving two small holes of water not exceeding ten acres area, and a few ponds here and there of sizes too insignificant to mention.

"The soil here is principally sand, underlaid at varying depths by very soft sand and limestone. There is some flint at great depths.

"Near the location where the water is thought to have made its exit the country is literally dotted with deep holes, varying from ten to forty feet in depth; the sides are steep and precipitous. These holes are commonly known here as sinks, and are sometimes formed in a single night.

"For days after the escape of the water from this prairie the stench of putrid fish was intolerable. The farmers hauled them off in wagons for fertilizers.

"On the prairie anywhere turtle shells can be seen, with here and

there the skeleton of some unfortunate alligator that has been killed by some marksman or by some stray hunter."—*Scientific American*, April 2, 1892.

Xanthidia.—Mr. E. W. Wetherell reports the occurrence of Xanthidia in the London clays. He has succeeded in isolating these minute fossils, and finds that for the most part they follow two types, easily distinguishable, although there are many minor varieties of each of them. These organisms are often found joined together in pairs, or with five or six individuals massed together.

Their characters are as follows: Shape, lenticular; some specimens far flatter than others, perhaps owing to pressure; spines around the edge and springing obliquely from the flattened sides; or, around the edge only. The length, thickness and number of spines gives rise to the two types. The diameter is about $\frac{1}{10}$ mm. When viewed by transmitted light the body portion is of a distinct green color, marked with black spots. Glycerin shows the whole form better than any other medium.—*Geol. Mag.*, Jan., 1892.

Geological News. Paleozoic.—A microsaurian is reported from the Lancashire Coal field. The fossil comprises the head, abdominal region and base of the tail of a small animal occupying the whole of an elongated split nodule 0.08 m. in length. It has been assigned to Hylonomus by A. Smith Woodward under the name *H. wildii*. Among distinctive specific characters may be enumerated the form and proportions of the mandible and dermal armor. (Geol. Mag., May, 1891.)——Mr. Malcom Laurie has described some Eurypterid remains from the Upper Silurian deposits of the Pentland Hills, Eng., one of which has been made the type of a new genus, *Drepanopterus*. This form is characterized by the great breadth of the carapace, and by the shape of the single limb which has been preserved. The limb is long and narrow, and ends in a slightly expanded sickle-shaped segment. The genus seems to be intermediate between *Eurypterus* and *Stylomerus*. (Proceeds. Roy. Acad., Dec., 1891.)——A new Clymenia has been discovered in the Naples Beds of Western New York. It is described and figured by J. M. Clarke under the name *C. neapolitana!* The genus Clymenia has been considered a horizon-marker of the uppermost Devonian, and its discovery in a lower Upper Devonian in company with *Goniatites intumescens* and representatives of the whole series of European Upper Devonian fauna suggests the idea that the fauna of the Naples Beds may be a condensed time-equivalent of a series highly differentiated in the transatlantic Upper Devonian succession. (Am. Jour. Science, Jan., 1892.)

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—Still another attempt to arrive at a just view concerning the chemical relations of eruptive rocks has been made, this time by Lang.[2] Calcium and the alkalies are regarded as the best indicators as to the relationships of the rock masses, and in this respect the new investigation departs widely from older ones, in which the silica was always considered as perhaps the most characteristic of a rock's chemical constituents. After citing a large number of analyses of rocks chosen from carefully examined types of all classes, the author divides rock magmas into four great groups, viz: Those in which the proportion of K_2O present exceeds that of CaO and Na_2O combined, or $K_2O > CaO + Na_2O$, and those in which the proportions of the components correspond to the following formulæ: $Na_2O >$, $CaO + K_2O$, $Na_2O + K_2O > CaO$ and $CaO > K_2O + Na_2O$. Each of these groups is then subdivided into types. In the first group, for instance are two orders in one of which $Na_2O > CaO$, and in the other $CaO > Na_2O$. In the first order fall the Cornwall granites with $CaO : Na_2O : K_2O = 1 : 4 : 14$; the Heidelberg porphyry with an alkali ratio of 1 : 1.5 : 8; the dyke granite type with a ratio of 1 : 3.7 : 6, the granite-rhyolite type with a ratio of 1 : 2 : 4, and the orthophyre type with 1 : 3.8 : 7.3. The second order includes the Hesse granite, syenite and bolsenite, with the respective alkali ratios $CaO : NaO : K_2O = 2 : 1 : 6$, 2.5 : 1 : 4 and 1.9 : 1 : 4.8. The other groups are likewise subdivided into orders, and in each of these are ranged the types. Brief notes accompany the descriptions of each type, and a table giving the percentages of the principal constituents of 247 fresh rocks closes the paper. Some of the relationships brought to light by the author's discussion are so unexpected that it may safely be affirmed that the views put forth in his article will meet with much opposition among petrographers. The granites, for instance, are discovered to occur in different orders, under different groups, the types being often further removed from each other than are normal granite and phonolite.——The new rock iolite, described by Ramsay and Berghell[3] fills the place in Rosenbusch's scheme that was left for the plutonic equivalent of the nephelinites. It is a medium to coarse-grained granular rock forming a large portion of the Mountain Iiwaara in the parish of Kunsamo, Finland.

[1]Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2]Min. u. Petrog. Mitth. xii, p. 199.

[3]Geol. Fören. i. Stockholm Förh. 13, 1891, p. 300.

It consists essentially of nepheline and pyroxene, with iiwaarite (a titaniferous garnet), apatite, sphene and cancrinite. Its structure is allotriomorphically granular, though the pyroxene often possesses one or more crystallographic faces. In the finer grained varieties the garnet is not common, but in the coarse-grained phases of the rock it occurs in large quantity. The pyroxene is zonal, with an almost colorless nucleus, surrounded by six or seven colored zones, in which the extinction is high and the color some shade of green. The mineral occurs either as isolated grains in the nepheline or in little nests of grains in this mineral. Cancrinite is not present in all sections, but in many it is abundant as a decomposition product of nepheline. The relationship of the iolite to nephelinite is shown not only in its possession of a titaniferous garnet, but in its chemical composition as well:

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	Na_2O	K_2O	P_2O_5	Loss	Total
Iolite.........	42.79	1.70	19.89	4.39	2.33	.41	11.76	1.87	9.31	1.67	1.70	.99	= 98.81
Nephelinite	43.89	1.24	19.25		12.00		10.58	2.81	9.13	1.73	1.39		=102.02

——In consequence of a recent expedition into the Peninsula of Kola, in Northwestern Russia, the senior[1] of the two authors last mentioned has had an opportunity to make a partial geological examination of this little-known territory. He finds the greater portion of the peninsula to be underlain by gneisses, mica schists and Devonian sedimentary beds. The mountains in the neighborhood of Lake Imandra are composed largely of an eleolite syenite, consisting of an intergrowth of albite and microline, eleolite, aegirine, arfvedsonite, eudialite, ainigmatite and a number of other rare and some new species. The aegirine forms long prisms whose extinction is about 4–5° and whose optical angle exceeds 114°. Sometimes a nearly colorless zone surrounds a dark-green kernel, but usually the prisms are dark throughout. An analysis of isolated material gave:

SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MnO	MgO	Na_2O	K_2O	Loss
51.82	.60	21.02	8.14	3.01	1.00	1.47	11.87	.85	.50

The arfvedsonite is rare in the normal rock, but is common in its peripheral phases in prismatic grains, whose extinction is 10°30′. The eudialite often possesses an idiomorphic outline bounded by OR, R and ∞P_2. Its double refraction is usually positive, but occasionally some portions of its grains are negative and other portions isotropic.

[1]Fennia. Bull. d. la Soc. d. Géog. de Finlande, 3, No. 7, p. 1.

This phenomenon leads the author to the assumption that eudialite and eukolite are the end members of an isomorphus series, of which the isotropic substances intermingled with the eudialite are intermediate members. Ainigmatite is found only in the peripheral masses as allotriomorphic grains with a pleochroism A = black > B = brown-red > C = carmine. One of the new minerals occurring in the coarse-grained rock has the composition :

SiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO	Na_2O	K_2O	H_2O
55.88	15.19		2.67	9.53	.53	9.06	1.57	6.04

It is isotropic or weakly doubly refracting. It shows no cleavage, is hard, and has a density of 2.753. Its color is light-red except in certain star-like areas where it is more deeply colored. It is one of the youngest of the rock's components. In the normal rock these constituents are so aggregated as to produce the trachytic structure. In the peripheral varieties aegirine, nepheline and the feldspars are in two generations. These minerals and eudialite occur as phenocrysts in a fine-grained green ground mass of the first three mentioned components, sodalite and the new minerals above referred to. The structure of this aggregate is intermediate between the hypidiomorphic and panidiomorphic. A dyke eleolite syenite from the same region has a thoroughly panidiomorphic ground mass.——In the course of a very exhaustive geological article on Mite Vulture, in Basilicata, Italy, Deecke[1] describes the products of the volcano as lavas and tufas. The former, with the exception of the hauyne-trachyte of Melfi, all possess a similar appearance. They are dark, compact or slaggy rocks with phenocrysts of augite and hauyne in a ground mass of leucite, nepheline, feldspar, augite, biotite, melilite, containing sometimes olivine, garnet, apatite and magnetite. The augite is in well formed idiomorphic crystals, both in the lavas and in the tufas. These are zonal with a yellow augite surrounded by a greenish zone, the material of which also separates as small crystals in the ground mass. The hauyne is the next component in abundance. It possesses the usual characteristics of this mineral, and alters into zeolites, of which the most important is natrolite. The leucite, nepheline, plagioclase and sanidine are usually in such small grains as to be visible only under the microscope. The latter mineral occurs also as an essential constituent in 1 cm. long crystals in the phonolite of LeBraidi, East of Melfi, and in some of the tufas. Olivine is found

[1]Neues. Jahrb. f. Min., etc., B. B. vii, p. 556.

only in the rock of the crater and in bombs, though it was probably more abundant during the first stages of consolidation of nearly all the lavas. Melilite and biotite are also rare, and both seem to have undergone more or less resorption. In addition to the minerals above mentioned bronzite is sometimes found in the olivine inclusions, and natrolite, phillipsite, gypsum, serpentine and kaolin as alteration products of other minerals. The most abundant lava of the volcano is leucite-tephrite, with nepheline, leucite, plagioclase and sanidine in varying proportions. A phonolite dyke was discovered at LeBraidi, as already stated. Otherwise phonolitic material is known only as tufa. At Melfi occurs the unique rock, many times described as a melilite hauynophyre. According to the author it should be classed as a hauyne-melilite-nepheline-leucite-tephrite. Basanites cut the older tephritic lavas in the crater of the volcano. Glassy base was detected only in some of the lapilli. The bombs thrown out during the active period of the volcano's history are either olivine bombs or aggregates of augite, biotite and hauyne. In the former the components are olivine, bronzite and biotite, the latter in micropegmatitic intergrowths with the other two. The tufas fall into two classes. In one sanidine and melanite are abundant ; in the other hauyne predominates. The first is the older, and includes the trachyte tuffs of earlier authors. It is a tephrite tufa, which sometimes contains little rounded grains of quartz. The hauyne tufa is more widely spread than the tephritic varieties, and is probably connected genetically with the phonolitic lava.

Mineralogical News—General.—Analyses of *långbanite* having led Flink to the complicated formula $37\ Mn_5\ SiO_3 + 10\ Fe_3\ Sb_2\ O_8$ as expressive of its composition, Backström[1] has thought it worth while to re-examine the mineral in the attempt to learn its true relationship to other nearly allied species. A new analysis yielded him:

[1]Zeits. f. Kryst., xix, p. 276.

Sb_2O_5	SiO_2	MnO	FeO	CaO	MgO
13.96	9.58	65.44	3.10	1.73	.53

Since chlorine is evolved when the mineral is treated with hydrochloric acid, the author concludes that the manganese is principally in the form of Mn_2O_3, while the remainder of the metal is present as MnO. The conclusion reached is to the effect that langbanite is not isomorphous with any known mineral, but is an isomorphous mixture

of Mn SiO_3, Mg SiO_3 and Mn SbO_3.——A large number of *chlorite* analyses are communicated by Ludwig,[1] to whom material was furnished by Teshermak. Among the varieties whose composition was determined are *pennine*, from the Zillerthal, *cronstedtite*, from Pribram, *korundophilite*, from Chester, Mass., *metachlorite*, from Elbingerode, *daphnite*, from Penzance, *tabergite*, from Taberg, *prochlorite*, from the Zillerthal and the Fischerthal, *leuchtenbergite*, from Amity, N. Y., and *clinochlor*, from Achmatowsk, Russia, and from Kariet, Greenland. The figures for korundophilite and leuchtenbergite follow:

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	H_2O	Sp. Gr.
Korund............	23.84	25.22	2.81	17.06	19.83	11.90	2.87
Leucht..............	30.28	22.13		1.08	34.45	12.61	2.68

These analyses of Ludwig and others that have recently been reported have afforded Tschermak[2] data for the elaboration of a theory concerning the constitution of the chlorites, according to which the members of this group of minerals are regarded as consisting of mixtures of six molecules, four being represented by the known minerals serpentine, amesite, strigorite and chloritoid, and the other two being hypothetical. Dr. Clarke[3] takes exception to Tschermak's views and shows that upon his own theory (that the chlorites are substitution derivatives of normal salts) the composition of these complicated minerals becomes simple, and that his theory is as closely in accord with the facts known as to the structure of the chlorites, as is the theory of the Vienna mineralogist.——In a discussion as to the relations of the recently discovered minerals pinakiolite and trimerite to well known groups Brögger[4] places the former among the rhombic aluminates, and the latter, as a pseudo-hexagonal species, between the olivine and the willemite groups. He further points out the similarity in morphological properties between all of these groups and ascribes their differences to morphotropic action. He regards all the silicates of the general formula R_4SiO_4 as composing a morphotropic group, in which trimerite is triclinic because R is replaced by two elements, viz: Be and Mn—Several *micas, vermiculites*, and *chlorites*[5] have been investigated by Messrs. Clarke and Schneider[6] by the

[1]Min. u. Petrog. Mitth. xii, p. 32.
[2]Akad. d. Wissens. in Wien., 1891.
[3]Amer. Jour. Sci., xliii, 1892, p. 190.
[4]Zeits. f. Kryst., xviii, p. 377.
[5]Cf. Becke: Min. u. Petrog. Mittl., xi, p. 259.
[6]Amer. Jour. Sci., Sept., 1891, p. 242.

methods[1] already noted in these pages. Some of the vermiculites seem to be composed simply of mica molecules, while in others these are intermingled with molecules possessing the characteristics of those of chlorite. Many analyses of vermiculites appear in the paper, and all of them bear evidence of careful work.——*Calcium-vanado-pyromorphite*[2] occurs in the Leadhills, Southern Scotland, as black masses with an irregular fracture. It melts easily to a brown crystalline enamel, and dissolves in hydrochloric acid, leaving a brown residue. Its density is 6.9–7.0, and in composition it is a pyromorphite with its lead and phosphorus partly replaced by calcium and vanadium.——

$Pb_3(PO_4)_2$	$Pb_3(VO_4)_2$	$Ca_3(PO_4)_2$	$PbCl_2$	$Cu(OH)_2$	Insol.
52.00	19.20	15.80	11.05	1.50	0.6

Crystallographic.—*Barite* crystals from veins cutting limonite and siderite, forming lenticular masses in limestone, interstratified with crystalline schists at Huttenberg, Saxony, have been studied by Brunlechner[3]. They are supposed to have originated by the leaching of barium silicate and its decomposition through the agency of carbonic acid into barium bicarbonate and silica, and by the further action of iron sulphate upon the barium salt. Well formed crystals are rare, but the author has succeeded in detecting upon them twenty-nine forms, of which the following are new: $\infty P\breve{\tfrac{11}{4}}$, $\infty P\breve{22}$, $\infty P\breve{30}$, $\infty P\breve{44}$, $\infty P\bar{\tfrac{6}{5}}$, $16P\breve{\infty}$, $20P\breve{\infty}$ and $4P\bar{\tfrac{7}{4}}$.——An examination of the crystals of *ullmanite* from Sardinia, in the possession of the British Museum, inclines Miers[4] to regard them as interpenetration twins of tetartohedral forms, whose apparent holohedral symmetry is due to twinning about the dodecahedral axis. If this is so, ullmanite is the first regular tetartohedral mineral known.——Melville[5] has investigated the diaspore crystals in the cavities of the quartz diaspore rock of Mt. Robinson[6]. One type consists of light-brown transparent forms, elongated parallel to *c*. Its planes in the order of their development are $\infty P\breve{\infty}$, ∞P, $\infty P\bar{2}$, $\infty P\bar{\tfrac{4}{3}}$, $\infty P\bar{\tfrac{7}{6}}$, $P\breve{\infty}$, P and $P\bar{2}$, with the axial ratio $= .6457 : 1 : 1.0689$. A second type comprises almost white, opaque crystals with a stout pyramidal habit, bounded by $\infty P\bar{2}$, $P\bar{2}$ and $\infty P\breve{\infty}$.——A very elabor-

[1] American Naturalist, 1891, p. 830.
[2] Collie: Jour. Chem. Soc., lv, 1889, p. 91.
[3] Min. u. Petrog. Mitth. xii, p. 62.
[4] Min. Magazine, ix, p. 211.
[5] Am. Jour. Sci., June, 1891, p. 470.
[6] Cf. American Naturalist, 1892, p. 166.

ate paper on the *vesuvianite* crystals in the serpentine of Testa Ciarva, Alathal, Piedmont, adds but little to our knowledge of these. The results recorded in it but confirm Zepharovich's observations. The crystals examined by the author, Strüver[1], numbered 123, each one of which was carefully measured, both as regards its dimensions and the planes occurring upon it. The number of forms found on each crystal is stated, and the number of crystals upon which each form was observed is mentioned. A plate appended to the article contains thirty-two figures, showing the arrangements of striations and the shapes of elevation and depression figures on the different faces.——In the second part of his article on the symmetry of crystals Beckenkamp[2] gives us some exact information concerning the vicinal planes and the etched figures of the *aragonite* of Bilin and the neighboring localities in Russia, and discusses the polarity of the crystal molecule, with especial reference to the explanation of the electrical properties of the carbonate and of its vicinal planes. The axial ratio of the aragonite crystals examined is .6228 : 1 : .7204.——In a recent article Sohncke[3] explains the structure of circularly polarizing crystals on the basis of his point-system theory of crystal-structure. He succeeds in showing that circularly polarizing crystals may be regarded as composed of thin lamellæ of doubly refracting substance, in which the different layers are revolved a certain number of degrees around their common axis.——Some very complicated twins of feldspar from the Pantelleria rocks are described by Foerstner[4]. They exhibit in the same group combinations of all the principal twinning laws known for the species. ——The *calcites* of fifteen localities in Baden have undergone the same exhaustive examination in the hands of Sansoni[5] as have those of so many other well known occurrences.——Miers[6] has measured the fourth crystal of *krennerite* ($Au_3\ Ag_3\ Te_6$) reported in mineralogical literature. It is from Nagyag, Hungary, and contains six new forms, viz.: $2P\breve{\infty}$, $3P\breve{\infty}$, $4P\breve{\infty}$, $2P\breve{2}$, $3P\breve{2}$ and $\frac{1}{2}P\breve{2}$. The axial ratio is 1.0651 : 1 : .5388.

Miscellaneous.—Following the work of Clarke and Schneider on the constitution of the natural silicates comes the report of a series of

[1] Neues. Jahrb. f. Min., 1891, p. 1.
[2] Zeits. f. Kryst. xix, 1892, p. 241.
[3] Ib., xix, p. 530.
[4] Ib., xix, p. 560.
[5] Ib., xix, p. 321.
[6] Miner. Magazine, ix, p. 182.

investigations on similar bodies made by Thugutt[1] in Dorpat. The author recounts the results of his experiments of digesting certain compounds with water and various chemicals for a long time at a high temperature, and describes minutely the products formed. By using the proper ingredients a series of sodalites was produced, in which sodium silicate, the corresponding selenite, sulphite, chlorate and other salts take the place of the chloride in the most common sodalite. The details of the experiments cannot be given, although they are extremely interesting. The formula thought to represent best the chemical properties of natural sodalite is $4(Na_2O, Al_2O_3, 2SiO_2) + 2\ Na\ Cl$. The treatment of corundum, a few silicates and natural glasses with water and alkaline carbonates shows clearly that each reagent is efficient in hydrating the substances upon which it acts. Many other conclusions of interest are reached through the author's investigations, but they cannot be mentioned here for lack of space.

BOTANY.

Myriostoma coliforme Dicks. in Florida.—A note upon the rare occurrence of *Geaster coliformis* may be seen in the ninth volume of Grevillia. It was found in England and first recorded in Ray's Synopsis in 1724; with long intervals it has been seen a few times since. It has been met with in a few localities on the continent. When I wrote the article on N. A. Geasters in THE AMERICAN NATURALIST in 1884, I was not aware that *Myriostoma coliforme* had ever been found in this country, but that paper brought out the fact that a specimen which came from Colorado was in the N. Y. State Museum of Natural History. This I noticed in the Journal of Mycology, Vol. I, No. 1.

Last summer Prof. L. M. Underwood found a nest of this rare and curious fungus in the vicinity of Eldorado, Fla. Through his kind consideration and liberality, I have come into possession of three specimens.

As no account of the internal structure has ever been given, I was eager to examine its interior and proceeded shortly to carve the largest specimen. A study of this enables me to fortify the opinion of Desvaux that this interesting species of the tribe *Geaster* should of itself constitute an independent genus. But let us examine it carefully beginning with the mycelium and the external surface.

[1]Mineralchemische Studien, Dorpat, 1891, p. 128.

Contrary to my surmise from the published description, the peridium is not invested with a thin frail cuticle emitting from all points of the surface slender filaments which bind it to the soil, as in *Geaster limbatus*, but a fibrous rooting mycelium proceeds from the lowest central point of the base, as in *Geaster saccatus*; hence the cuticle is persistent. A stout fibrillose layer succeeds forming the main structure of the plant and connecting with the inner peridium at the base by the numerous pedicels. These are angular or prismatic in shape, sometimes rather flattened and just about 2 mm. in length. A thin fleshy layer lines the inner surface, which is not at all hygrometric as in *Astræus*. The inner peridium is depressed-globose and has the silver-gray lustre mentioned by the old botanists; the surface also is roughened with minute pointed warts, as noticed by Plowright, and this fact leads me to infer that the inner and outer peridium are at first united by what De Bary terms a *split-layer*, as is the case in *Astræus hygrometricus*.

Now as to the internal structure. There is no columella such as we find in all true Geasters. The inner peridium has a soft fleecy lining of fine slender threads, in the dry state much curled and entangled. By careful manipulation, I found each thread to be a long simple structure, brownish in color by transmitted light, 3–4 μ in thickness in the middle and tapering to a fine point at each extremity; it is attached to the membranous wall by one end and of course is free at the other; so far the agreement of the threads is with those of *Geaster*, but a peculiarity now occurs.

The pedicels fuse at once into the wall of the peridium and are not erected in any way into one or more columellas. Instead the threads of the fleecy lining concentrate at numerous points upon the base, elongate and becomes compacted together forming several irregular branched processes, which attain half the height of the peridium. These processes remind me forcibly of the numerous dendroid columellas which are erected from the base in the Myxomycete, *Reticularia lycoperdon*; indeed the silvery surface of the peridium in the two is altogether similar.

Mingled with the spores, I find numerous *free* threads similar to those which grow upon the inner face of the wall but much shorter; I suspect that these grow upon the trama along with the spores and are left free by deliquescence as in *Bovista*. If this is true it is a unique feature. But I am not able to assert this positively from the mature specimens.

The numerous mouths do not appear to have any correspondence either in number or position to the pedicel. It is doubtful to me whether they are determinate, but they seem rather to be ruptures at thin and weak spots between the warts. At any rate they are not regularly fimbriate as in many of the Geasters, but such a fimbriate appearance as may be seen is due to the protrusion of the threads of the fleecy lining by the emission of the spores.

It is therefore most probable that *Geaster columnatus* Lev. must be included in the species under discussion, and there is hence but this one unique species as yet known in the world.—A. P. MORGAN, Preston, O.

Notes on Ginseng (*Aralia quinquefolia*).—Ginseng root is now dug in large quantities in Canada and exported from Canada to the United States, to supply the demand among the Chinese. In order to prevent its eradication the parliament of Ontario has found it necessary to pass a law prohibiting the digging of it except at certain seasons.

This trade is a revival of one of which formerly existed. In 1715 Père Lafitan, a Jesuit father, who was stationed near Montreal, saw a letter of Père Jartoux, who had seen ginseng in Tartary a few years before and gave a description of it. Père Lafitan, ascertaining that the root was worth its weight in gold at Pekin, and that there was "large money" in it, searched the country, and inquired from the Indians, in order to find it, which he succeeded in doing. A company was formed to export it to China, Japan and Tartary. The price at Quebec was from thirty to forty cents a pound. At first anyone was allowed to sell it, but as its value increased the company exercised its monopoly rights, and in 1751 undertook to exclude all others from the trade. As the demand increased the care exercised in procuring and preparing the root relaxed. It was dug out of season, and imperfectly dried in stove ovens. As a result the value of the export fell off from five hundred thousand livres in 1752 to thirty-three thousand livres in 1754. Canadian ginseng came to have such a bad reputation that the export ceased entirely.

When the trade was at its height it was considered more profitable to dig ginseng than to cultivate the farm, and agriculture was almost entirely neglected. For a time the trade was hardly less important than that in fur.

The revival of the demand has caused great activity in the search for ginseng, especially in the country to the north of Kingston, Ont.,

where it is said to abound. The average wholesale price is one dollar per pound, while it retails at five dollars. In the desire to participate in the large profits made in this trade some curious mistakes have been made. A man who thought he had a rich find in Manitoba, discovered, after buying several tons, that he had not the right article, having probably confused gentian with ginseng.

If the trade is to be preserved care will have to be exercised in digging and preparation. The root does not reach any great size in one season, but takes years to develop.

The Chinese word *genseng* and the Iroquois word *garent-oquem*, the Indian name of the plant both signify "a man's thigh," and have doubtless been applied because of a fancied resemblance of the human body. Upon this coincidence Père Lafitan based an argument that America had once been joined to Asia, and that the inhabitants of the former had migrated from the latter before the continents had become separated at Bering Strait.

Panax fructicosus and *Panax cochleatus*, fragrant aromatics, which grow in the Moluccas, and are used by the native practitioners of India, are plants somewhat akin to ginseng. The native Chinese ginseng is probably another species of the same genus as that found on this continent.—J. JONES BELL, Toronto, Canada.

Popular Botany.—It is a good sign of the increase of biological ideas in connection with botany when one finds such a book as "A Song of Life," which has recently came from the pen of Margaret Warner Morley, and which A. C. McClurg has brought out in such an attractive form. The first chapter only, "Flowers," relates to plants, the others dealing with fishes, frogs, birds, etc., but in spite of its title it discusses flowers less, and plant life, and reproduction more. The illustrations are very good, and most artistically arranged below, above and through the pages of poetically worded, and withal quite exact text. We hope to see more of such books.

Jane Newell's "Flowers and Fruits," recently brought out by Ginn & Co., continues the pleasant and instructive lessons begun a couple of years ago. They are designed "for the use of teachers, or mothers studying with their children." The book will be useful.—CHARLES E. BESSEY.

ZOOLOGY.

Fresh-Water Sponges.—Prof. D. S. Kellicott has arranged the fresh-water sponges collected by the late Henry Mills and has published an account of them[1] with a key to the genera. Sixteen species are enumerated. Prof. Kellicott regards the region around Buffalo bay as affording ideal conditions for a fresh-water fauna as the water remains at an almost constant level, and with comparative moderate changes in temperature.

Parasites of Salmon.—F. Zschokke,[2] after a careful study of the parasites of *Salmo salar*, the author comes to the following conclusions: 1. Thirty-three species of helminths infest the salmon; 2. The habits of *S. salar* differ in different bodies of fresh water, for (a) the absence of fresh water parasites in the Rhine salmon shows that in this stream no food is taken by them, (b) the occasional presence of fresh water parasites in the salmon of the Tay proves that food is occasionally taken in that stream, (c) while the very frequent presence of fresh water parasites in the salmon of the Baltic Sea shows that it is the regular custom of this fish to feed in the rivers and brackish water of that region.—C. W. Stiles.

Anatomy of Stenostoma.—H. N. Ott publishes[3] a preliminary note on the structure of this Rhabdocœlous Turbellarian which is essentially like most Microstomidæ, the relations of the muscles of the body walls which is called peculiar, being the normal condition in the Turbellaria. The olfactory pits are imbedded directly in the brain. In fission a constriction of the ectoderm precedes alteration of the entoderm.

The Systematic Position of Orthelosoma.—L. v. Graaf has had an opportunity to study the type of this genus in the British Museum, described by the late J. E. Gray as a slug. He finds[4] that, as Leuckart had previously supposed, this so-called mollusc is in reality a land Planarian, closely allied to Rhynchodesmus. Von Graaf states

[1]Bulletin Buffalo Soc. Nat. Sci., V., p. 99, 1891.

[2]Die Parasitenfauna von Trutta salar, in Centralblatt für Bakt. u. Parasitenkunde, 1891, Vol. x, No. 21–25.

[3]Zool. Anz. xv., p. 9., 1892.

[4]Zool. Anz. xv., p. 8., 1892.

that the type of Guilding's Herpa from the West Indies is not to be found. It was also described as a mollusc, but it has Planarian characters.

Haplodiscus.—L. von Graaf[1] gives his opinion of Weldon's *Haplodiscus piger* from the Bahamas, which was thought by its describer to be possibly allied to the Cestodes or Trematodes. It is, says von Graaf, an acœlous Turbellarian, with zooanthellæ, with central mouth, two genital openings and apparently with a chitinous terminal portion to the bursa. These characters would assign it to the genus Convoluta.

Echinorhynchi in America.—It has long been known that the swine in this country are commonly affected with these parasites. Dr. C. W. Stiles has recently solved the problem of the intermediate host of the worm (Zool. Anz. xv, p. 52, 1892). In Europe it had been demonstrated that two or three of the Scarabæid beetles acted as such host and so they were used as the basis of experiment here. Eggs of Echinorhynchus were sprinkled on the food (tender roots, etc.) of the larvæ of Lachnosterna and subsequent investigation showed that the larvæ were distended with the young. As farmers are in the habit of turning their hogs into fields which are infested with the 'white grubs'—larvæ of the June bugs—it is easy to see how the parasites can be communicated to the swine, provided, of course, that the grubs be affected. On the other hand the grubs may be readily infected from the fæces of a single infested hog.

The Species of Panopæus.—James E. Benedict and Mary J. Rathbun monograph[2] the species of this essentially American genus of Cancroid Crustaceans. Eurytium and Eurypanopeus are included as synonyms. Twenty-four species have been examined and as a supplement a list of fifteen more nominal species is given of which no specimens have been seen. Some three thousand specimens were examined in the preparation of the paper. The present writer once studied this genus but did not publish his results. He is of the opinion that the number of species here admitted is about three times too large, for the species are very variable.—K.

Pycnogonid Studies.—Schimkewitsch[3] revises the species of the genera Phoxichilus and Tanystylum. In the introduction Wilson's

[1]Zool. Anz. xv., p. 6, 1892.
[2]Proc. U. S. Nat. Mus., xiv, 355, 6 pls., 1891.
[3]Arch. Zool. Exp., ix, 503, 1891.

genera Anoplodactylus and Scæorhynchus are regarded as synonyms of Phoxichilidium and Eurycyde respectively.

Gamasid Mites and Ants.—Mr. A. D. Michael, in a paper read before the Zoological Society of London, Dec. 1st, 1891, came to the following conclusions: (1) That there is an association between some Gamasids and Ants; (2) That a species of Gamasid usually associates with one or two species of Ants preferentially; (3) That the Gamasid of ants nests are not usually found elsewhere; (4) That the Gamasid abandons the nest if the Ant does; (5) That the Gamasids live upon friendly terms with the Ants; That the Gamasids are not true parasites; (7) That they do not injure the Ants or their young; (8) That the Gamasids will eat dead Ants, and are probably either scavengers or messmates.

Lepidoptera of Buffalo.—E. P. van Duzee publishes[1] a list of the Macro-Lepidoptera of the vicinity of Buffalo, N. Y. In all 777 species are enumerated. In the arrangement W. H. Edwards is followed for the butterflies and Aug. Grote for the Moths excepting the Sphingidæ and Agrotidæ, where J. B. Smith has been followed, and the Phycidæ, which are arranged according to G. D. Hulst.

The Position of the Solenoconchæ.—Dr. L. Plate,[2] after a brief account of the structure of Dentalium, Siphonodentalium, Siphonentalis and Cadulus, concludes that these forms show more relationship to the Gasteropods than to the Lamellibranchs in "(1) the unpaired shell; (2) the radula; (3) the jaws; (4) the tentacles, which can only be homologized with those of the Gasteropods; (5) the body retractors, which in origin and position correspond to the spindle muscles; (6) the pleural ganglia, which among the Lamellibranchs occur only in the Nuculidæ, forms which otherwise show no special similarity to the Dentalia; (7) the strong development of the buccal nerve centres; (8) the œsophageal glands, which from position are to be homologized with the salivary glands of the Gasteropods. Grobben's hypothesis that 'the Dentalia are to be regarded as the survivors of an ancestral form and especially the ancestors of the Cephalopod' is supported [upon the supposition that] the arms of the cuttle fishes, as appendages of the head, are homologous to tentacles of the Solenoconchæ. It appears to me that recently the pedal nature of the

[1]Bulletin Buffalo Soc. Nat. Sci., V., p. 105, 1891.
[2]Verh. Deutsch. Zool. Gesellsch. i. 60, 1891.

Cephalopod arms has been certainly shown.'" Prof. Grobben at the same meeting replied saying, among other things, that the radula and pleural ganglia had no diagnostic value, since there was some evidence that the ancestors of the Lamellibranchs had a radula which had secondarily been lost, while the existence of the pleural ganglia in the Nuculidæ, the oldest of existing molluscs, had great weight. He had no ground to alter his previous view that the Dentalidæ were the modified descendants of the group from which the Cephalopods had sprung. The arguments advanced by Plate for regarding the arms of the cuttle fishes as pedal were not conclusive. Profs. Bütschli and Leuckart spoke to a similar effect, the latter assigning these forms a middle position between Gasteropods and Lamellibranchs.

The Genera of Enteropneusta.—Prof. Spengel[1] recognizes among the 19 known species of this group four genera, separated most sharply by the body musculature. In Ptychodera alone is there an outer circular musculature; Glandiceps and Schizocardium have inner circular muscles, while in Balanoglossus proper no ring muscles exist. Other differential characters are given. Cephalodiscus is not recognized as a member of the group. No species are mentioned.

Extinct or Nearly Extinct Vertebrates.—Mr. A. F. Lucas has a readable article upon the animals which are recently extinct or threatened with extinction as represented in the National Museum.[2] The West Indian Seal (*Monachus tropicalis*), is uncertainly placed in this category for but little is known of it, and its habits and habitat seem favorable for its perpetuation. The California sea-elephant (*Macrorhinus angustirostris*) is possibly entirely extinct, none having been recorded since 15 were sent in 1884 to the National Museum. The walruses, too, are threatened with extinction, the Pacific species, *Odobœnus obesus*, being in greater danger than the Atlantic *O. rosmarus*. The source of danger lies in the whalers who capture the animals for oil and ivory. Between 1870 and 1880 there was brought to market 1,996,000 gallons of walrus oil, and 398,868 pounds of walrus ivory. In 1879 the ivory was worth 45 cents a pound; in 1880, $1.00 to $1.25; and in 1883, $4.00 to $4.50. The European bison (*Bison bonasus*) which is at present restricted to Lithuania and the Caucasus, is protected in both localities. In 1880 the Lithuanian herds numberd but 600 and the number is smaller at present. The

[1] Verh. Deutschen Zool. Gesellsch. i. 47, 1891.

[2] Report National Museum for 1888–89, p. 609, 1891.

Arctic sea-cow, (*Rytina gigas*), the history of which has already been given in our pages,[1] was exterminated in 1767 or 1768.

Three species of birds from the Hawaian Island are probably extinct. The last ornithological collector who returned from these islands found no specimens of the Mamo (*Drepanis pacifica*), and but about half a dozen specimens represent the species in museums of the world. It was probably exterminated in obtaining feathers to make the yellow war cloaks of the Sandwich Island Kings. The Hawaian *Chætoptila augustipluma* is represented but by two specimens, and the small tailless rail (*Pennula ecaudata*) of the same archipelago is nearly as rare. It would appear that nearly all the native birds of the islands are also threatened with extermination.

The California Vulture (*Pseudogryphus californianus*) is now extremely rare, and largely restricted to Southern California. "The free use of strychnine in ridding the cattle ranches of wolves and coyotes has caused the disappearance of this bird, which has been poisoned by feeding on the carcases prepared for the four-footed scavengers." The Dodo (*Didus ineptus*) of Mauritius, and the Solitaire (*Pezohaps solitaria*) of Rodriguez, have a history too well known to be recounted here. They are represented in the National Museum by a few bones.

So, too, the fate of the Labrador duck (*Camptolæmus labradorius*) and of the great Auk (*Alca impennis*) has often been told. Of the former but 36 specimens are in existence. Two of these in the National Museum were collected by Daniel Webster. The last specimen was taken in 1878. Specimens of the Great Auk are not so rare, and yet they command enormous prices. The last skeleton sold brought $600, the last skin $650 and an egg brought $1500. The Great Auk was probably exterminated in 1840.

Pallas' Cormorant (*Phalacrocorax perspicillatus*) of the region around Kamschatka has a brief history. It was killed by man for food. In 1741 it was "frequentissimi" on Bering Island. About a hundred years later it was extinct and is represented to-day by four stuffed specimens and twenty-three bones in all the museums of the world.

Of the lower vertebrates Mr. True refers to the great Galapagos tortoises and their relatives of the Mascarene Islands, and the Tile fish. The forms have already formed the subject of a paper by Dr. Baur in this Journal[2] and it is only necessary to say that probably

[1] L. Stejneger Am. Nat., xxi, p. 1047, 1887.

[2] Am. Nat. xxiii, p. 1039, 1889.

they are exterminated from another of the Galapagos group. The giant tortoises of the Mascarene Islands were extremely abundant in the seventeenth and eighteenth centuries, but their use as food caused their extinction at the beginning of the present century. "Save the few bones rescued from the marshes of Mauritius and the caves of Rodriguez, nothing is left to show that these large and formerly abundant tortoises ever existed."

The history of the Tile fish (*Lopholatilus chamæleonticeps*) is among the strangest known. So far as we have any information, no one, fisherman or naturalist, ever saw a tile fish (the common name is an abbreviation of the generic) until March 1879, when a Gloucester fishing schooner took about 6000 pounds. In the following years 1880 and 1881 a few were taken by the U. S. Fish Commission Steamer. In March and April 1882 vessels arriving in American ports reported passing through large numbers of dead and dying fish off the southern coast of New England and Long Island. Vessels reported sailing for forty to sixty miles through floating fish, (in one instance through 150 miles) so that it became evident that a vast destruction had taken place. Capt. Collins estimates from these reports that an area of 5000 to 7000 square statute miles were so thickly covered that the total numbers must have exceeded a billion. The next fall the Fish Commission searched in vain for these fish on the ground where they were formerly so abundant; and no one has since reported a specimen.

Zoological News.—Vertebrates.—Carl H. and Rosa H. Eigenman publish[1] a very useful catalogue of the fresh-water fishes of South America. 1135 species are enumerated. The great richness of the fauna in the Nematognathi is here made very prominent, 449 species of that order being enumerated.

Mr. A. J. Allen[2] publishes the first part (Osines) of a catalogue of the birds collected by Mr. Herbert H. Smith at Chapada, Matto Groso, Brazil. Mr. Smith and his party obtained some 6000 skins in this locality and of these some 5500 are utilized in preparing the present paper. In all the collection represents about 350 species in all phases of plumage. 87 species are included in the present paper.

At a meeting of the Zoological Society of London, Feb. 2, 1892, R. Lydekker "described part of an upper jaw of a Sirenian Mammal

[1]Proc. U. S. Nat. Mus., xiv, p. 1–81, 1891.

[2]Bull. Amer. Mus. Nat. Hist., iii, p. 337, 1891.

from the Tertiaries of Northern Italy, containing milk teeth. As these teeth showed a masked Selenodont structure it was urged that the specimen indicated the descent of the Sirenia from the Selenodont Artiodactyle Ungulates;" an exceedingly improbable suggestion.

ENTOMOLOGY.

The Robertson Cyanide Bottle.—Many entomologists have experienced more or less trouble in using the commonly recommended plaster-of-Paris cyanide bottle on account of the moisture that accumulates on the inside. I was recently shown by Professor Chas. Robertson, of Illinois, a plan he has adopted which is simple, practical, and causes no trouble of this kind. He uses wide-mouthed bottles with cork stoppers. He cuts out of the lower side of the cork a hole large enough to receive a small pill box. The pill box is filled with cyanide; a dozen pin holes are made through its bottom; and then it is inserted in the hole in the cork. The fumes pass through the pin holes into the bottle. Such a bottle can be easily washed out, and has many advantages especially for flies, bees and similar insects.—C. M. W.

Entomological Notes.—Professor A. J. Cook, of Michigan, spent the winter in Southern California. * * * Professor J. H. Comstock of Cornell University has been at the Leland Stanford Junior University during the winter, lecturing on entomology. * * * Professor Chas. Robertson, of Illinois, is studying the relations of flowers and insects in Florida. * * * Professor J. B. Smith, of Rutgers College, recently visited Europe to study types of Noctuidæ.. * * * Miss Mary E. Murtfeldt has contributed to the December *Insect Life* an interesting note on the "Hominivorous Habits of the Screw Worm in St. Louis." * * * Mr. Albert Koebele, of the U. S. Department of Agriculture has gone to Australia for more beneficial insects.

Professor Forbes' Sixth Report.—The seventeenth report of the State Entomologist of Illinois for the years 1889 and 1890 has lately been issued. Like its recent predecessors it gives evidence of the careful, exhaustive work so characteristic of Professor Forbes' investigations. The report proper covers about 100 pages with an appendix of 40 pages. In the general record for the two years covered it is stated that the previous prediction concerning the disappearance of the chinch bug outbreak had proven correct. Two species of aphides (*Siphonophora granaria* and *Toxoptera graminum*) had appeared in the grain fields; the former having "inflicted the worst injury upon agriculture ever done in Illinois by any plant-louse species." The general discussions include the following titles: "The

Fruit Bark Beetle" (*Scolytus rugulosus*), the best article concerning this insect yet published; "Experiments With the Arsenical Poisons for the Plum and Peach Curculio," showing the susceptibility of the beetles to poisoning; "The American Plum Borer" (*Euzophera semifuneralis*) with description of stages and notes on life history; "On the Common White Grubs," an important contribution on a little-known subject; "Additional Notes on the Hessian Fly," showing the life-cycle of this pernicious pest; "A Summary History of the Corn Root Aphis," "On a Bacterial Disease of the Larger Corn Root Worm" and "Notes on the Diseases of the Chinch Bug." The appendix consists of "An Analytical List of the Entomological Writings of Wm. Le Baron, M. D., Second State Entomologist of Illinois," and is accompanied by a well executed plate portrait of Dr. Le Baron. The report is also illustrated by three colored and four plain plates of original drawings by Mr. A. M. Westergren. The colored plates represent the corn leaf louse, corn root louse, and the grain louse, in a most accurate and artistic manner.—C. M. W.

The Illinois Insectarium.—In his recent Sixth Report, noticed above, Professor S. A. Forbes gives the following account of the Insectarium recently provided for the State Entomologist of Illinois: "The experimental work of the office has been greatly facilitated, and rendered far more accurate and profitable by the new Insectarium, or experimental entomological laboratory, provided for by the Legislature at its last session. It has been in constant and extensive use from the date when it was ready for occupancy.

"The important part of this Insectarium is essentially a conservatory fifteen feet by thirty, standing entirely above ground with glass roof and brick walls, with the exception of the end wall which is glass above the level of the sides. The building stands north and south, opening to the south with double doors, one of glass and one of wire gauze. The roof is covered with four rows of sash all hinged at the ends in such a way that the sash of the lower row can be lifted at the lower end, while the sash of the upper row may be opened widely at the peak of the roof. The glass on the lower row of sash upon each side is deadened with white paint (that of the upper row being left clear) and the admission of sunlight is further controlled by a screen of cheesecloth sliding on wires extending along the entire middle of the room beneath the two central rows of sash. The upper sashes are opened and closed by a ventilating apparatus which moves all together, while the lower are conveniently raised by hand. The

room is divided into two apartments connected with double doors, one of which is provided with hot water pipes.

"With these arrangements it was easy to keep the temperature within one or two degrees, above or below, that of the outer air, whatever the weather might be. The interior is furnished with tables in benches, work-tables, etc., for breeding-cage and root-cage work, and contains a brick-lined trench, three feet wide and fifteen feet long by three feet deep, cemented within, and filled with earth, for the larger plants, and for small plot experiments."

MICROSCOPY.[1]

Notes on Celloidin Technique.—The high value of celloidin as an imbedding mass is well-known, and its superiority over all methods requiring heat is unquestioned, yet, from the fact that its manipulation has been attended by many difficulties, it has not come into general use. During the past two years I have tried the methods recommended by various authors and have found none entirely satisfactory, especially where very long series were necessary. The results of my experience are embodied in the following method:

The prepared plates or fragments are placed in an air-tight chamber; a four-ounce salt-mouth bottle being very suitable for this purpose. Pour into this bottle just enough ether-alcohol (equal parts acid-free sulphuric ether and absolute alcohol) to cover the fragments. The ether-alcohol should be added until after occasional shaking no celloidin remains undissolved; this may take several days. It should finally possess the consistency of a very thick oil. The solution thus obtained may be labelled No. 4. No. 3 is obtained by taking two volumes of No. 4 and diluting with one volume of ether-alcohol. No. 2 by proceeding in a like manner with No. 3. No. 1 is a mixture of absolute alcohol and sulphuric ether in equal parts.

The saturation and final imbedding is accomplished thus: The object is transferred from 95% alcohol to solutions 1, 2, 3, 4 successively, in each of which it remains from a few hours to days, depending upon the size and permeability. For pieces of tissue 2 mm. in diameter twenty-four hours in each will generally suffice. For a large brain, *e. g.* that of a cat, a week in each will not be too long.

In imbedding, unless orientation is desired, the ordinary paper box is best. A thin plate of lead is placed in the bottom and the imbed-

[1]Edited by C. O. Whitman, Clark University, Worcester, Mass.

ding solution poured in. The object is taken from the same solution and with needles wet in ether placed in the desired position. Fine needles may be passed through the box to support the object.

In hardening, the method given by Viallanes of immersing in chloroform is preferable, since the operations may be carried on with much greater rapidity. An air-tight chamber should be filled with chloroform; a very wide-mouth bottle will answer. After the mass is thoroughly hardened, which requires about twenty-four hours, it is removed, the paper cut from the sides and transferred to 70% alcohol for a few hours.

It is now ready to fix for sectioning. Blocks are trimmed to fit the clamp of the microtome. Solution No. 3 is poured over the block; into this the celloidin block is pressed, after dipping the under surface in solution No. 1. Place in chloroform until hardened.

Reconstruction points are often very desirable. For this purpose the ordinary metallic imbedding box (fig. 1) made of two L-shaped pieces, *a* and *á*, held in place by the overlapping strips *b*, is used. The ends and sides are perforated in as many places as desired by a very small drill. The holes should be so drilled that the silk threads which are drawn through run parallel. After being drawn tightly they are cemented to the sides of the box by a drop of celloidin. Five or six cm. of the thread should be left hanging. The bottom of the box is made by fitting in a piece of heavy blotting paper. The object is placed upon the threads in the desired position, and the imbedding mass poured in. As soon as hardened the celloidin holding the threads is dissolved by a drop of ether. The loose ends are soaked in solution No. 2, which has been thickened by the addition of lampblack. The threads are then drawn through, leaving the lampblack adhering to the celloidin, thereby forming excellent reconstruction points.

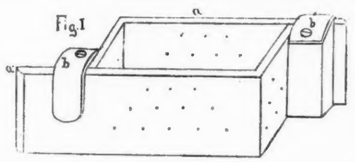

FIG. I.

For small objects where reconstruction points are not needed the following method may be advantageously employed. The heads are clipped from fine insect pins, which are then placed in handles in such a way that they may be easily removed. On these pins the objects are oriented in the desired position; the pins are then removed from the handles and fixed in a cork (fig. II, *a*) previously perforated by a

somewhat larger pin. As fast as the pins carrying the objects are inserted the cork is replaced in the tube, which is filled with alcohol. A half dozen fish or amphibian ova may be oriented on the same cork. If desirable to draw the objects *in situ* a piece of lead may be pinned to the cork and the whole immersed in a small beaker of alcohol. The corks carrying the oriented objects are transferred successively to tubes containing the different solutions. When ready for final imbedding a piece of porous paper is wrapped about the tubes and cork and pinned. The cork is now removed, allowing the imbedding solution to fill the paper tube thus formed. A lead is fastened to the cork and the whole placed in chloroform until hardened, after which the paper is cut from the mass and the pins drawn through the cork, when it is ready for sectioning. This method offers many advantages in that several objects may be cut at the same time, drawings may be made after orientation, the objects are transferred from one solution to another more rapidly, etc.

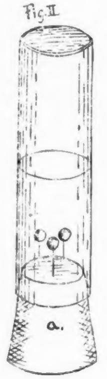

FIG. II.

In cutting, care should be taken that the knife is placed as obliquely as possible and kept constantly wet with 70% alcohol. For this purpose an ordinary pipette provided with a large rubber bulb is used. As fast as cut the sections are drawn back on the blade of the knife, by means of a needle, and arranged in a single row until the blade is filled. To remove them a heavy paper spatula is placed directly upon the section to which it adheres and may be drawn off the edge of the knife and transferred to the slide. By slight pressure together with a rolling movement the section is left in the desired position. Sufficient alcohol is kept on the slide to prevent drying but not enough to allow the sections to float. When the requisite number have been arranged they are covered with a strip of toilet paper which is held on the slide by winding it with fine thread. The sections being thus firmly held in position may be stained, etc. They should not be placed in absolute alcohol but cleared from 95% in a mixture of equal parts of bergamot oil, cedar oil and carbolic acid. When cleared the excess of fluid is removed by a piece of blotting paper; with gentle pressure sections which are by chance loose are firmly fixed in position, the thread is now cut, the strip of paper rolled back, balsam and cover applied.

If the object can be stained *in toto*, which is often the case, much time may be saved by the following method: The stained object is imbedded in the usual manner, but after hardening in chloroform, and

removing the paper, the celloidin block is transferred to 95% alcohol for twenty-four hours, then to carbolic acid[1] or glycerin in which it becomes as transparent as glass[2]. The block is fixed in the usual manner.

Orientation is now accomplished with the greatest ease. In cutting, the knife is wet with the clearing medium given above. The sections may be arranged in serial order on the knife-blade until a slide-full is obtained, when they are transferred, balsam and cover applied. By this method long series may be readily handled. Glycerin is used only when the mounting medium is glycerin; in this case the knife is wet with glycerin.—A. C. EYCLESHYMER.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—April 6th.—The following papers were read: Percival Lowell, Shinto Occultism, God-possession of the People; Harold C. Ernst, Some of the Advances in Bacteriology.—SAMUEL HENSHAW, *Secretary pro tempore.*

The Biological Society of Washington.—March 19th.—The principal paper of the evening was The Biological Basis of Psychology, by Prof. Lester F. Ward. The following communications were read: C. D. Walcott, On the Discovery of Certain Cambrian Fossils on the Coast of Massachusetts; F. H. Knowlton, The Fossil Flora of the Bozeman Coal Field; C. W. Stiles, Notes on Parasites. *Strongylus rubidus* Hassall and Stiles, '92.

April 2d.—The principal paper of the evening was The Interdependence of Plants and Insects, by Prof. C. V. Riley, illustrated by lantern slides. The following communications were made: C. Hart Merriam, The Distribution of Tree Yuccas, illustrated; H. E. Van Deman, Variations in the Fruit of *Hicoria Pecan;* C. W. Stiles, Notes on Parasites; Two Stages in the Life History of *Distoma magnum* Bassi 1875. (*D. americana* Hassall 1891.)—FREDERIC A. LUCAS, *Secretary.*

[1]Bumpus, (Am. Nat., Jan. 1892) advises the use of thymol.

[2]Since discovering this method of rendering celloidin blocks transparent which was published in the Bot. Gaz. 1890 I have found that the clearing mixture given above answers the same purpose as the carbolic acid but requires a little longer time.

SCIENTIFIC NEWS.

Sereno Watson.—On the 9th of March descriptive botany suffered a great loss in the death of Sereno Watson, for many years the Curator of the Gray Herbarium of Harvard University, and since Dr. Gray's death, the successor, and botanical executor of the kind-faced master. It was hoped that the work which Dr. Gray left unfinished would be completed by Dr. Watson, who was so well prepared to do it, but we are again left with the work incomplete. Torrey, Gray and Watson all worked along the same lines, and may be said to have maintained the same school of systematic botany. Had they completed the "Flora of North America," the impress of their ideas would have remained for all time. As it is, the fragments of the work will be gathered and arranged by other hands, and the thoughts of other men will be wrought into it.

Born in 1826 in East Windsor Hill, Conn., Dr. Watson was at the time of his death in his sixty-sixth year. He graduated from Yale in 1847, and subsequently taught school for a number of years, at one time being a tutor in Iowa College, then located at Davenport, Iowa. He studied medicine and was a practicing physician for a time in Illinois, abandoning this for other occupations. In 1867, when forty years of age he began his first botanical work in connection with the United States Geological Exploration of the Fortieth Parallel, under the charge of Clarence King. His report on botany in 1871 (vol. v. of the series) is a worthy monument to his descriptive ability, and at once gave him a prominent place in science. His labors since then have been unremitting. The two magnificent volumes of the "Botany of California" were largely his work. So too, the "Manual of Mosses" by Lesquereux and James, owes much to him. His "Bibliographical Index to North American Botany" will for many years to come stand as a monument to his industry, and he will long be remembered gratefully by many a botanist who finds here at a glance reference which would have taken many hours of searching.

In 1873 he began his series of "Contributions to American Botany" by the publication of a paper in the May number of this journal entitled "New Plants of Northern Arizona and the Region Adjacent." The "separates" were designated as No. I. of the series of contributions. No. III. also appeared in this journal (November, 1873), treat-

ing of the "Section Avicularia of the genus Polygonum." With the exception of No. VIII.—"The Poplars of North America"—published in the American Journal of Science and Arts, all other numbers were published in the Proceedings of the American Academy of Arts and Sciences. These reached to XVIII., which was issued July 31, 1891.

Personally Dr. Watson was a most genial man, full of a quiet cheerfulness, and good-fellowship which attracted those who knew him. His industry was comparable to that of his English counterpart George Bentham. The cheerful face, the pleasant voice, the quiet steady worker will be sadly missed from the ranks of American botanists.—CHARLES E. BESSEY.

A seaside laboratory of Natural History in connection with the Leland Stanford Jr. University, will be opened during the coming summer at Pacific Grove, California, on the Bay of Monterey about half way between Monterey and the Point of Pines. This laboratory will be for the purpose of investigations in the life-history of the marine animals and plants of this coast. It will be under the direction of Profs. Gilbert, Jenkins and Campbell of the chairs of zoology, physiology and botany respectively. It will be open to naturalists and others wishing to make special investigations in the anatomy or life-history of animals and to teachers of natural science. For further details those interested may apply to any of the directors at Palo Alto, Cal.

Mr. G. Pouchét gives in Revue Scientifique the following statement of reforms which he thinks should be introduced in the Museum and Jardin des Plantes of Paris.

The reforms which seem to be most urgent are as follows:

1. A more direct participation, more active and better conducted, by the official board of the Museum, both in its finances and its several departments.

2. The restriction of the optional positions to the newly appointed professors of natural history. The Ministerial Commission have hitherto jeered at this reform.

3. The participation of the professors of the Museum who are members of the Institute or doctors of science in the examinations for licentiate or doctorate of natural science.

4. The gradual suppression, or at least the transfer, to Vincennes of the menagerie.

5. The publication of an official bulletin instead of the costly *Annales*, which the Museum is reputed to publish.

6. The suppression of pensioned students and especially the residentiary canons.

7. Finally, the non-reëligibility of the director nominated for five years.